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THESIS

The Incorporation of Changes
in an Existing Flight Schedule

by

Jeri L. Teevan
June 1990

Thesis Advisor   Dr. Neil C. Rowe

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This research examined the effectiveness of using computers in making personnel changes to an existing training flight schedule. The program uses heuristics based on the flight regulations provided by Chief, Naval Air Training Command for Advanced Strike Flight Training. The program was developed in C-Prolog on an Integrated Solutions, Incorporated (ISI) Optimum V Workstation.

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The Incorporation of Changes in an

Existing Flight Schedule

by

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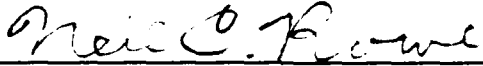for the degree of

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ABSTRACT

This research examined the effectiveness of using computers in making personnel changes to an existing training flight schedule. The program uses heuristics based on the flight regulations provided by Chief, Naval Air Training Command for Advanced Strike Flight Training. The program was developed in C-Prolog on an Integrated Solutions, Incorporated (ISI) Optimum V Workstation.

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I. INTRODUCTION

A. NEED FOR A RESCHEDULING PROGRAM

Frequent changes are a fact of military life: changes in personnel due to transfers, illness and unexpected problems, changes in available equipment and changes in weather. One of these problems multiplies the effect of any of the others occurring: personnel turnovers. The many rules and regulations governing the scheduling of training flights are confusing at the best of times; however, the frequency of personnel changes prevents any one person from becoming fluent in these regulations.

1. Personnel Turnovers

In all branches of military service, one of the most inhibiting factors in the smooth operation of a command is its personnel turnover. These personnel changes are continuous and occur in all areas of a command. The extent to which they impact a command's mission is directly related to the complexity of the affected job.

The more complex a job is, the more details and restrictions involved, the longer it takes one to become proficient at it. The use of pass-down logs and turnover notebooks is beneficial, but in themselves they do not provide the immediate knowledge and experience necessary to execute the job proficiently. This lack of experience can be balanced by a computer program with the requisite knowledge.

A computer program can be an aid in those mission-essential areas where experienced personnel are needed to maintain continuity. The position of

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Schedules Officer is one of these areas. The mission of a flight training squadron revolves around the effective scheduling of students, instructors and aircraft in such a way as to make effective use of resources.

2. Regulations and Requirements

A schedule is defined as "A list of the time certain things are to happen; timetable, ..."[Ref. 1]. This broad definition leaves unsaid the specifics applied to each type of schedule. These specifics are what make each scheduling problem unique and prevent a generic scheduling program which will cover all cases.

Our particular schedule is designed to assist in the daily scheduling of instructive flights as required by the Chief, Naval Air Training Command. The assets to be scheduled include, on the average, 70 students and 35 instructors. In addition to the timing requirements, the schedules officer must consider the number of combinations available in the ordering of the flights, the last-minute changes due to instructors and students not being available, the vagaries of the weather and mission priorities. The many requirements and restrictions involved in creating this schedule preclude a single person from being conversant in all areas of the process.

While here we are concerned with making changes to an existing schedule, the same requirements, regulations and problems exist with creating a full flight schedule. This thesis is designed to provide a program which will aid in this effort.

B. OBJECTIVES

Our objective is to eliminate the problems associated with personnel turnovers while dealing with other personnel changes. Flight schedules are developed a day prior to their execution, so not only the students and instructors

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can be prepared, but also so those people responsible for available aircraft and simulators will know what is required for them to complete their mission effectively. As in most things, last minute changes are inevitable. Illness, emergencies, etc. can severely impact a day's schedule if the time periods and other flights associated with the affected person are cancelled and left idle. The intent here is to eliminate these idle periods by either making a substitution for that student or instructor, substituting another flight for the remaining student or instructor, or completely rescheduling the time period. Rather than spend hours manually trying to change the flight schedule, the Schedules Officer can update the schedule in minutes using this program.

C. REMAINING CHAPTERS

Chapter II examines some alternate methods in developing a scheduling and rescheduling program, including the simulated annealing and optimization approaches. In Chapter III we describe the problems this thesis is attempting to solve and the assumptions made in its design. The actual program is described in Chapter IV, including technical details. The results of this study are presented in Chapter V, and finally, in Chapter VI, a summary of the strengths and weaknesses of this program.

Appendix A contains the source code for the program, with the exception of the **actual flight schedule** module and the **database** module which are in Appendices B and C, respectively.

Appendix D contains the resulting schedules from three different personnel changes made to the actual flight schedule in Appendix B: an instructor change resulting in a simple instructor substitution, a student change resulting in a

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change of flight for the remaining instructor and an instructor change resulting in a complete rescheduling of the time period.

II. ALTERNATE APPROACHES

Scheduling includes the arrangement, coordination and planning of the utilization of resources to achieve an objective. Until recently resources and equipment were the primary restrictions in scheduling, with time being a readily available commodity. Now these restrictions have reversed; time is scarce, with resources and equipment available. As a result of these timing constraints, the use of computers in developing efficient schedules is becomming more widespread.

There are many methods, approaches and languages that can be used to create a scheduling/rescheduling program. Here we examine two approaches: search and simulated annealing.

A. SEARCH

In his June, 1989 master's thesis [Ref. 2], Robert Powell developed a program for use in creating a near-optimal training schedule for flight squadrons. It involves the scheduling of squadrons and inspection teams, allowing for timing constraints and operational commitments.

Powell's technique works in a hierarchical manner, using no-path and hill-climbing searches, to reduce the amount of time and space required to create a computerized schedule. The three stages of the hierarchy are:

- establish the initial database required to create the schedule

- determine which month is best for each event to occur in, and assign everything to its best month when possible; otherwise, rearrange the best-month assignments the minimum amount necessary to avoid conflicts

- optimize the schedule by determining the best days for each event.

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Like Powell's original problem, the scheduling of student training flights involves scheduling two variables, students and instructors, within a specified time frame. This time frame, a day, is further divided into events and times, rather than months and days. Due to the similarities in the two scheduling problems, this three-stage program would provide a near-optimal result.

The foundation of our thesis is more in line with the second stage of Powell's thesis. It is simply a series of rescheduling maneuvers until conflicts are eliminated.

B. SIMULATED ANNEALING

Howard E. Shrobe [Ref. 3] describes simulated annealing as a technique, often used by neural networks, that tries to take the path of steepest schedule-cost decrease. However, in this case, the search is allowed to accept a temporarily higher-cost solution, based on a programmer-defined probability function, in the hopes of gaining a lower-cost final solution. This acceptance of a higher-cost path occurs frequently at the beginning of the search. As time passes, acceptance of higher-cost paths becomes more limited. Like its parent technique, iterative improvement, simulated annealing provides a locally optimal solution. However, by allowing the upward movement as well as downward, the result is a more globally near-optimal solution.

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III. APPLICATION DESCRIPTION

A. EXISTING PROBLEM

The flight schedule is manually developed each day for use the following day. It is then used as a guide for students and instructors to prepare for the appropriate flight, for the simulator instructors to know how many students to plan for and for what flights, and by the civilian contractors to know the number of aircraft required for them to fulfill their contract.

The schedules officer is tasked with developing a flight schedule that ensures effective use of squadron/wing resources. In doing this he relies on several sources of information: the snivel log, student completions and instructor qualifications as well as applicable regulations.

1. The Snivel Log

The Snivel Log is a book of handwritten notes made by the individual students and instructors indicating when they are unavailable to fly. Periods of leave, medical disqualifications, and other obligations, i.e., department head meetings, are noted here. This log is often difficult to read and incomplete.

2. Student Completions

A flight completion tracking chart is notated with the date of each flight as a student completes it. This chart is designed for ensuring a student completes all required flights, rather than providing easy access to the last date the student flew. As a result, students often exceed the ten-day maximum of allowed days between flights. When this occurs, a warm-up flight is provided to reacquaint the student with flying techniques previously learned. A warm-up flight requires

an instructor, student, aircraft, and a two to three hour block of time that would otherwise be available to further student training.

3. Instructor Qualifications

Each instructor is qualified to instruct specific stages of training, i.e., Familiarization, Formation, etc. These qualifications are tracked by the Standardization Officer to ensure an appropriate number of instructors are qualified to instruct in each segment. There are occasions when a requalification date is overlooked or delayed. This can cause serious problems for the Schedules Officer if he is unaware of the lapse.

B. REGULATIONS

Chief, Naval Air Training Command (CNATRA) provides guidance on all phases of flight training. The Master Curriculum Guide for Advanced Strike Flight Training [Ref. 4] determines the requirements for each flight while CNATRAINST1542.48 series [Ref. 5] provides the overall phase guidelines.

The Advances Strike curriculum consists of fourteen stages: Academics, Aviation Student Information (ASI), Basic Instructions (BI), Radio Instruments (RI), Airways Navigation (AN), Familiarization (FAM), Formation (FORM), Night Familiarization (NF), Tactical Formation (TACF), Operational Navigation (ON), Weapons (WEPS), Out-of-Control Flight (OCF), Air Combat Maneuvering (ACM) and Carrier Qualification (CQ). The Training Hour Summary provided in Figure 1 shows the requirements to complete each of these stages.

The flights from these 14 stages are divided into 12 modules, shown in Figure 2, and combined with academic instruction, flight support and simulator

training.

ADVANCED STRIKE FLIGHT TRAINING			
STAGE	**SYMBOL**	**TOTAL FLIGHTS**	**TOTAL HOURS**
BASIC INSTRUMENT	BI	2	2.8
RADIO INSTRUMENT	RI	4	5.7
AIRWAYS NAVIGATION	AN-1-10x	5	8.1
FAMILIARIZATION	FAM	10	12.4
BASIC FORMATION	FORM	5	7.0
TACTICAL FORMATION	TACF	4	5.6
NIGHT FAM/FORMATION	NF	5	6.4
OPERATIONAL NAVIGATION	ON	7	9.7
APPLIED INSTRUMENT NAVIGATION	AN-12,13 -15,-17 -18	5	7.8
OUT-OF-CONTROL FLIGHT	OCF-3	1	.8*
AIR-TO-GROUND WEAPONS	WEP	11	12.1
AIR COMBAT MANEUVERING	ACM	13	14.7
FCLP/CARRIER QUALIFICATION	CQ	14	10.4
TOTALS		8 6	103.5

SIMULATOR TRAINING			
STAGE	**SYMBOL**	**PERIODS**	**HOURS**
COCKPIT ORIENTATION	CO	5	10.0
EMERGENCY PROCEDURES	EP	2	3.5
BASIC INSTRUMENTS	BI	8	16.0
RADIO INSTRUMENTS	RI	11	22.0
AIRWAYS NAVIGATION	AN	8	16.0
TOTALS		3 4	67.5

*OCF-3 is flown in the T-2C and is counted in the training hour summary for totaling purposes.

Figure 1. Training Hour Summary

MODULE	FLIGHTS	SIMULATORS
0	ACADEMICS ONLY	
1		
2	BI 9-10x	CO 3s-5s
		BI 1s-8xs
3	RI 12-15x	RI 1s-11xs
4	AN 6-10x,	AN 1s-5xs, AN-11s
	AN 12-13,	AN 14s-15s, CO-7s
	AN 16-18	
5	FAM 1-10	CO-8s
6	FORM 1-5	EP-8s
7	NF 1-5	
8	ON 1-7	
9	TACF 1-4	
10	WEPS 1-11	
11	OCF-3,	
	ACM 1-13	
12	CQ 1-14x	EP-9s

Figure 2. Module Description

modules are given in sequence except where modified by the sequencing guidelines.

C. ASSUMPTIONS

We based our program on the scheduling problem for an Advanced Strike Flight Training squadron/wing. This provided the phase stages, flights, number of hours and prerequisites for each flight that we needed to formulate the rescheduling techniques.

The squadrons/wings have little control over the number of available aircraft since the repair work is performed by a civilian contractor. Therefore, the flight schedule is formulated without regard to the available aircraft. The schedule is, in fact, used as documentation as to the contractor's performance.

This program will be used by people who have been in the aviation community and are accustomed to specific terminology. An example is 'snivel log', which, although meaningless to anyone outside the aviation field, has a common and well known meaning to an aviator. We used these insider terms to maintain clarity and allow immediate conversion to the program from the manual method.

We also assumed the actual flight schedule module contains valid information concerning the schedule date and time of sunset, and that the facts containing the schedule details are in the proper format.

IV. PROGRAM DESCRIPTION

A. REQUIREMENTS

The rescheduling program we wrote for this thesis was done on an Integrated Solutions Incorporated (ISI) workstation running the UNIX operating system. The program was written in C-Prolog, a Prolog interpreter written in C for 32-bit machines.

B. STRATEGY

To accomplish the desired goals, we developed the program to take advantage of Prolog's backtracking capabilities, which increases efficiency and speed. It also reduces the size of the program to about one-third of what a similar program written in a language without the built-in backtracking would be.

Also, as changes are made in personnel, the file containing the flight schedule information is updated. New *sked* facts replace the older, invalid facts. This enables the squadron/wing to always have a current, updated flight schedule.

C. MODULE DESCRIPTIONS

The rescheduling program was divided into nine separate modules to improve readability and flexibility. The source code for each is contained in Appendix A, except as noted. Figure 3 shows how the modules interrelate. They are:

- **reschedule**
- **update_database**

- snivel_log

- update_snivel_log

- change_personnel

- print

- completions

- actual flight schedule file

- database.
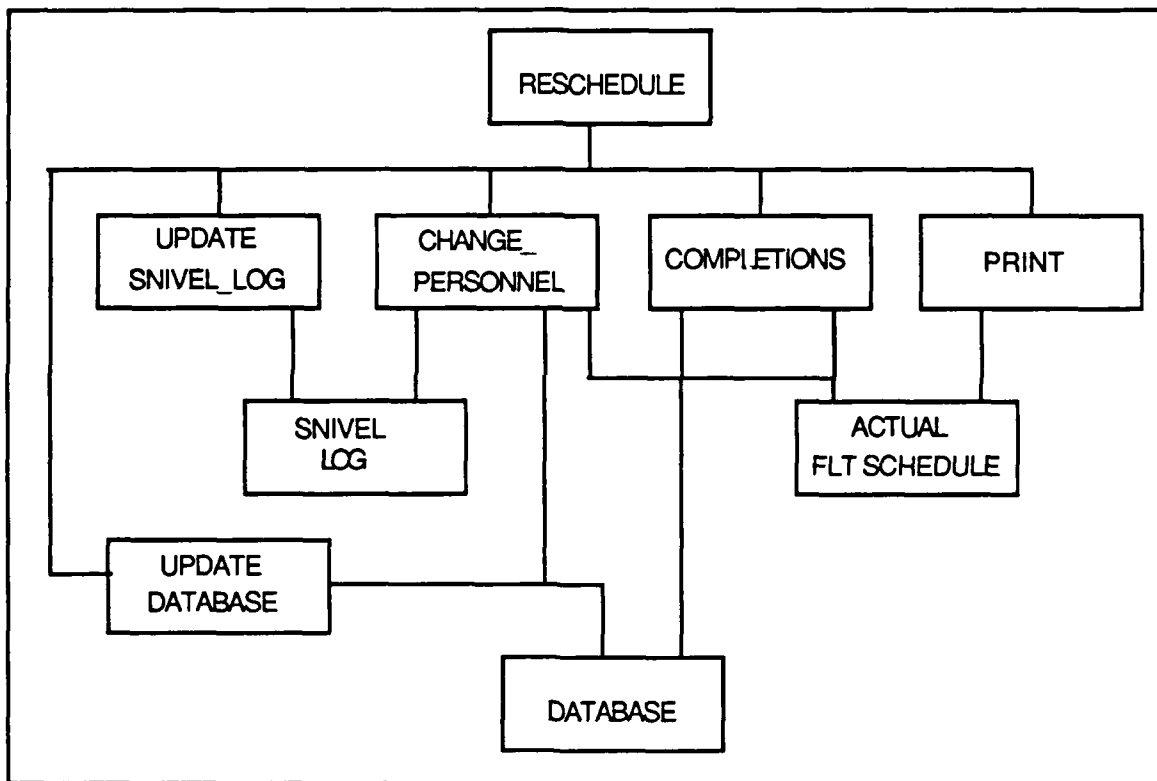
Figure 3. Program Module Block Diagram

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1. Reschedule Module

The **reschedule** module is the main module and contains the top level predicate, flight_schedule. Flight_schedule enables the other routines in the program to be called. The other modules are loaded here as needed.

2. Update_database Module

When students are ready to begin the flight and simulator portions of their training, they are entered into the **database** module via the **update_database** module. Likewise, when a student has completed his/her final flight, they are removed from the database.

Instructors, once they have received qualification in a stage, are entered in the database along with the qualification expiration date. This expiration date will automatically cause removal of the qualification fact on that date; however, if an instructor transfers prior to expiration, they will be deleted from the database via this interface module.

3. Snivel_log Module

The **snivel_log** module maintains all 'unavailable' periods for students and instructors. The snivel contains the student/instructor name, the date and the beginning and ending times of the period.

4. Update_snivel_log Module

This interface module allows the user to add to, delete from or change existing snivels within the **snivel_log** module. When a snivel is added, the user enters all the details: the name, date, and beginning and ending times of the period. All dates are entered in YYMMDD order and times are entered in 24-hour time. For changes and deletes, the name and date are entered. For

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changes, answering the questions appearing on the screen will correctly change the snivel. For deletes, the snivel appearing on that date will be removed.

5. Change_personnel Module

All personnel changes to the existing flights schedule are made via the **change_personnel** module. When a change is desired, the first priority is to maintain the remaining member of the flight crew. This can be done in two ways:

- finding a replacement for the deleted person and executing the same flight

- finding another flight the remaining person is qualified for, then finding a replacement student/instructor.

If neither of these options is possible, the time period for the flight is rescheduled using the scheduling heuristic, selecting the student with the longest idle period since his last flight and attempting to schedule for them.

6. Print Module

The **print** module prints the flight schedule using the actual flight schedule module. The schedule is printed chronologically beginning with the 0600 take-off time.

7. Completion Module

The **completion** module uses the actual flight schedule module to determine the what flights have actually been completed vice those that were cancelled. These flights are presented to the user for him to enter the flight hours completed during the flight. The flight is recorded in the database and the flight hours are added to the student's night or simulator hours if applicable.

Unless the flight was a simulator training flight, the flight hours are also added to the number of total hours.

8. Actual Flight Schedule Module

This module varies depending on the desired schedule. Each day's flight schedule is placed in a different file, since there are usually at least two schedules being worked on. Each file contains the date of the schedule, the time of sunset and the details for each scheduled flight. The user enters the file name of the schedule he/she wants to access. The file is then loaded as this module. Appendix B contains a sample schedule module.

9. Database Module

The **database** module [Appendix C] contains all the facts and flight rules for the program, with the exception of the snivels. These are contained in the **snivel_log** module.

D. DATA STRUCTURES AND MANIPULATION

The data structures we used can be broken down into three categories: those unaffected by the Schedules Officer, those partially or indirectly affected by him and those directly affected by him. Table 1 provides an explanation of the terms used in the argument specifications.

1. Data Structures Unaffected by the User

Those data structures unaffected by the user consist of fundamental flight information unlikely to change. A change in personnel or in a flight schedule has no impact on them. The structures in this category are:

- flight_duration(<flight>, <duration>).
- segment(, <flight>, <flight_type>).

- prereq(<flight>, <prerequisite flight>).

- doable(<flight>, <student_name>, <time>).

Flight_duration is used for determining the estimated time of event (ETE) for the flight schedule. This fact is stored in the database module and used by the **change_personnel** module.

Segment is used for determining which segment a flight is in and what type of flight it is. The segment is then used to determine which instructors are qualified to instruct that flight, while the flight_type determines whether it must be flown in a simulator, at night, etc. *Segment* is stored in the database module and used by the **change_personnel** module.

Prereq is used for establishing the next possible flight for a student. It takes the flight being considered for scheduling and checks the database to ensure the student has completed the prerequisites. *Prereq* is stored in the database module and is used by the **change_personnel** module.

Doable is also used for establishing the next possible flight for a student. The difference between this and the prereq fact, is that doable consists of flights that have multiple prerequisite flights or those that have special prerequisites, i.e., no less than 63 night hours achieved, night flights must begin no earlier than 30 minutes past sunset.

2. Data Structures Partially or Indirectly Affected by the User

These data structures are affected by the user, but only to a limited extent. The data structures in this category are:

- student(<name>, <total_simulator_hours>, <total_night_hours>, <total_aircraft_hours>, <date_last_flew>).

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- instructed_by(,<instructor_name>,<qualification expiration_date>).

- sked(<event>, <squadron>, <student_name>, <instructor_name>, <flight>, <take-off_time>, <estimated_time_of_event>, <remarks>).

Student is the fact type that maintains the up-to-date status of a student. A student is entered in the database when ready for his first flight and removed when the last flight is completed. Between input and deletion it is not manipulated directly by the user. The flight hours entered by the user upon completion of a flight are established as *completed* facts. These facts are then used by the program to maintain the current totals here. Also upon completion of a flight, the flight schedule date is entered into date_last_flew to indicate the student's idle time between flights. This is used in the heuristic to ensure students proceed relatively equally through the program and prevent warm-up flights. *Student* is maintained in the database module and used by the **update_database, change_personnel** and **completions** modules.

Instructed_by facts are added as instructors become qualified in a stage. The user enters the information and does not manipulate it again unless the instructor leaves before the qualification expiration date. Otherwise, the program removes the fact when it reaches the expiration date. *Instructed_by* is maintained in the database module and used by the **update_database** and **change_personnel** modules.

Sked is the fact type containing the individual elements of the schedule. This fact is manipulated indirectly when a change in an existing student or instructor is requested. *Sked* is stored in the **actual flight schedule** module and is used by the **change_personnel, print** and **completions** modules.

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V. PROGRAM RESULTS

A. TEST DATA

The data used to test this program was designed specifically to allow all the possible options of the rescheduling process to be tested. To maintain as close a resemblance to the real scheduling problem as possible, we developed a database containing 35 instructors and 70 students, the average number of each in an advanced strike flight training squadron. The schedule period times are those used by the training squadrons, although, usually a squadron schedules for every other period rather than each one as in our test schedule. By scheduling every period, we can more thoroughly test the program's performance.

B. STORAGE REQUIREMENTS

The program requires 196,428 bytes of storage when consolidated with another 2,376 bytes for the **actual flight schedule** module. Table 1 shows a breakdown of the individual modules and a typical time to required to access each.

In observing the program performance, we tracked three internal data areas used by C-Prolog: the heap, global stack and local stack. In each of the run times we will compare these areas.

C. RUN TIMES

In each of the test runs, we concentracted on making a single change to the flight schedule to better compare the performance in each portion. To do this,

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we tested three different sections: instructor replacements, student replacements and completely rescheduling the time period. In each test run, the cpu time

TABLE 1. TYPICAL STORAGE AND TIMING REQUIREMENTS

Module	Storage Requirement	Access Time
Update_database	6,628	0.816671
Snivel_log	576	0.100006
Update_snivel_log	5,868	0.700005
Change_personnel	9,944	1.20001
Print	3,160	0.383339
Completions	2,604	0.316685
Actual flight schedule	2,376	0.450016
Database	167,648	28.8167
Total	198,804	32.783432

includes the time required to process through the menus, add the student/instructor to the **snivel_log** module, execute the required schedule change and print the resulting flight schedule. *The script of each test run is included in Appendix D.*

1. Instructor Replacement

To reschedule for a cancelled instructor, the program first tries to make a simple substitution for that instructor, using the same flight and student. If that is not possible, the program proceeds to find another flight the student can fly and then finds an available instructor. The system requirements for replacing an instructor are given in Table 2.

a. Instructor Substitution

This replacement requires the least amount of time to execute. The search for a substitute is limited to checking specific segment qualifications and

ensuring the chosen instructor has no conflicts with the schedule period. The cpu time required to make an instructor substitution is approximately 60 seconds.

b. Flight Substitution

To substitute a flight, the program fails in its attempt to substitute the instructor. It then begins to search for other flights the student is eligible to fly by searching the doable and prereq fact types for possible flights. When a flight has been found, a search is again instigated for a qualified instructor. Since the search is limited to a single student and a specific time period, this is not a time-consuming execution; it requires approximately 80 cpu seconds.

TABLE 2. INSTRUCTOR REPLACEMENT REQUIREMENTS

Activity	Heap	Local Stack
Instructor Substitution	242,768	4,948
Flight Substitution	242,348	5,408

2. Student Replacement

In rescheduling for a cancelled student, the search for a replacement is much more extensive than for an instructor. The program will first try to find a student to replace the cancelled one using the same instructor and flight. If no student is eligible to fly that flight, it then moves on the changing the flight to another one the instructor is qualified to instruct. The system requirements for replacing a student are shown in Table 3.

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a. Student Substitution

This replacement requires a limited amount of time to execute. The search for a substitute student requires searching the database for a student who is qualified to fly the same flight as the cancelled student. Once a student is chosen, the program then ensures he has no conflicts with the scheduled time. The cpu time required to make a student substitution is approximately 70 seconds.

b. Flight Substitution

To substitute a flight maintaining the scheduled instructor, the program fails in its attempt to make a substitute for the cancelled student. It then begins to search for students who will qualify for flights the scheduled instructor is qualified to instruct. Since the search is not limited to a single student or flight segment, this is a time-consuming execution; it requires approximately 910 cpu seconds.

TABLE 3. STUDENT REPLACEMENT REQUIREMENTS

Activity	Heap	Local Stack
Student Substitution	245,148	8,892
Flight Substitution	245,156	8,920

3. Reschedule Period

Rescheduling the entire time period is the last resort in both of the above situations. By the time this is attempted all other options have been

exhausted. Since this is the case, this is the highest-cost option, time-wise, and requires approximately 1000 to 2000 cpu seconds to execute. The system requirements for rescheduling a time period are given in Table 4.

TABLE 4. PERIOD RESCHEDULING REQUIREMENTS

Activity	Heap	Local Stack
Instructor Reschedule	245,944	8,916
Student Reschedule	245,232	8,920

VI. CONCLUSION

The purpose of this thesis was to demonstrate the possible improvements available to the manual method of changing a flight schedule. Although this program does not include the multi-plane-leader flight possibilities, the results of the limited test runs show the speed and accuracy available through Prolog.

Currently, the entire scheduling process is done manually, from original development to final recording of completions. The improvement in the rescheduling process showed the possibilities available in other areas of scheduling, i.e., the original development, Instructor Under Training (IUT) scheduling, etc.

This rescheduling program was developed in separate modules with the intent of creating a program that can be changed and incorporated into a larger, more involved scheduling program as it develops. The advantages of Prolog will become more evident in a more involved scheduling effort.

Although Chief, Naval Air Training Command will soon begin using a commercially contracted Ada program to develop the daily flight schedule, it is not currently available and the details of its performance are unknown. One of the program specifications is that it create the flight schedule in less than 15 minutes. No mention was made of its strategy or primary focus. We envision our program as an adjunct to that one.

The use of our rescheduling program will be impractical if the primary schedule is developed in Ada. The extra manual effort required to convert the Ada database into Prolog format would nullify the savings of the rescheduling program. A conversion program is an alternative that can be explored, as well

as a comparison between a schedule written in Prolog and the commercial Ada program.

The user interface incorporated into the program is a very straightforward, simplified, interface devised strictly to test it. However, it does allow for options other other than the personnel changes the program was developed for. Although all are necessary to create a meaningful flight schedule, the program also provides an accurate check on the flight hour totals required for annual reports and grade checks for periodic student training jacket inspections.

APPENDIX A

SOURCE CODE

This appendix contains the main body of source code. The Actual Flight Schedule Module is in Appendix B and the Database Module is in Appendix C.

To execute the program, load Prolog then load the file **reschedule**.

%prolog

C-Prolog version 1.5

I?-[reschedule].

From this point the needed modules are loaded by the program or the user is asked for the file name of the file he wants to work with.

```
/******************************************************************/
/*      Module Name:   Reschedule                                 */
/*      Purpose:       The driver for the reschedule program      */
/******************************************************************/


flight_schedule :- nl, tab(5), write('Loading data . . .'), nl, nl,
        [database, update_database, snivel_log, update_snivel_log,
        change_personnel, completions, print], nl, tab(5), write('Remove '),
        write('instructor segment qualifications expiring as of what '),
        write('date?  '), read(X), read(DISQUAL_DATE),
        doall(delete_expired_quals(DISQUAL_DATE)), asserta(filename(none)),
        repeat, do_sked(ANS), (ANS = 'Y'; ANS = 'y'), !, return_databases, nl.

delete_expired_quals(DISQUAL_DATE):- instructed_by(SEG, NAME, DATE),
        not(DATE > DISQUAL_DATE), retract(instructed_by(SEG, NAME, DATE)),
        nl, tab(5), write('The '), write(SEG), write(' qualification for '),
        write(NAME), write(' has been removed.').
delete_expired_quals(DISQUAL_DATE):- nl, tab(10), write('END INSTRUCTOR '),
        write('QUALIFICATION UPDATE.').

do_sked(ANS) :- repeat, do_choices(MAIN_CHOICE),
        MAIN_CHOICE = quit, write('Do you want to quit?  '), read(ANS).

do_choices(MAIN_CHOICE):- display_main_menu, get_from_menu(MAIN_CHOICE),
        call(MAIN_CHOICE).

display_main_menu :- put(12), nl, tab(15), write( 'FLIGHT SCHEDULE' ), nl, nl,
                     tab(15), write( '  1  Database' ), nl,
                     tab(15), write( '  2  Changes' ), nl,
                     tab(15), write( '  3  Snivels' ), nl,
                     tab(15), write( '  4  Print' ), nl,
                     tab(15), write( '  5  Completions' ), nl,
                     tab(15), write( '  6  Change files' ), nl,
                     tab(15), write( '  7  Quit' ), nl, nl,
                     tab(15), write( 'Enter choice, 1 to 7:  ' ).

get_from_menu(MAIN_CHOICE)  :- read(CODE),
                               interpret(CODE, MAIN_CHOICE), !.

interpret(1, db_changes).
interpret(2, call_changes).
interpret(3, snivels).
interpret(4, call_print).
interpret(5, call_completions).
interpret(6, change_files).
interpret(7, quit).
interpret(OTHER, correct_entry).


call_changes:- filename(FILENAME), ck_file_status(FILENAME), changes, !.

call_print:- filename(FILENAME), ck_file_status(FILENAME),
        print_flight_schedule, !.

call_completions:- filename(FILENAME), ck_file_status(FILENAME),
        record_completions, !.

ck_file_status(FILENAME) :- not(FILENAME = none).
```

```prolog
ck_file_status(FILENAME):- FILENAME = none,
        write('What file do you want to work with?  '), read(NEWFILE),
        nl, write('Loading schedule file . . .'), nl, nl,
        consult(NEWFILE), retract(filename(FILENAME)), tab(10),
        write(NEWFILE), write(' is now open.').

change_files:- nl, nl, tab(10), write('What file do you want to work with?  '),
        read(NEWFILE), nl, nl, filename(FILENAME), different_file(NEWFILE,
        FILENAME), !.

different_file(NEWFILE, FILENAME):- (NEWFILE = 'Q'; NEWFILE = q).
different_file(NEWFILE, FILENAME):- FILENAME = none,
        nl, tab(5), write('Loading schedule file . . .'), nl, nl,
        retract(filename(none)), consult(NEWFILE), tab(10), write(NEWFILE),
        write(' is now open.').
different_file(NEWFILE, FILENAME):- FILENAME = NEWFILE, tab(10), nl,
        write(FILENAME), write(' is open.').
different_file(NEWFILE, FILENAME):- not(FILENAME = none), not (FILENAME =
        NEWFILE), nl, tab(5), write('Loading schedule file . . .'),nl, nl,
        return_sked_file(FILENAME), consult(NEWFILE), tab(10),
        write(NEWFILE), write(' is now open.').

correct_entry:- tab(20), write('Invalid entry.').

quit.

return_databases:- nl, nl, tab(5), write('Closing data files . . .'),
        filename(FILENAME), return_sked_file(FILENAME),
        tell(database), listing(filename), listing(student),
        listing(instructed_by), listing(doable), listing(get_night),
        listing(find_time), listing(prereq), listing(segment),
        listing(flight_duration), listing(completed), told,
        tell(snivel_log), listing(snivel), told.

return_sked_file(FILENAME):- FILENAME = none.
return_sked_file(FILENAME):- not(FILENAME = none), tell(FILENAME),
        listing(filename), listing(date), listing(sunset), listing(sked),
        told, retract(filename(FILENAME)).


?- flight_schedule.
```

```
/*******************************************************************************/
/*      Module Name:   Update_database                                        */
/*      Purpose:       Adds and deletes instructors as they qualify and       */
/*                     disqualify in flight segments                          */
/*                     Adds students as become ready for their first flight   */
/*                     and removes them as they complete their final flight   */
/*******************************************************************************/


db_changes:- display_db_menu, get_from_db_menu(DB_CHOICE), put(12),
        call(DB_CHOICE).

display_db_menu:- put(12), nl, tab(15), write(' DATABASE CHANGES '), nl, nl,
        tab(15), write(' 1  Instructor'), nl,
        tab(15), write(' 2  Student'), nl,
        tab(15), write(' 3  Quit'), nl, nl,
        tab(15), write(' Enter choice, 1 to 3:  ').

get_from_db_menu(DB_CHOICE):- read(CODE), decipher(CODE, DB_CHOICE), !.

decipher(1, instr_db).
decipher(2, stud_db).
decipher(3, quit).
decipher(OTHER, correct_entry).


    /*  makes changes to 'instructed_by' facts in datase  */

instr_db:- display_instr_db_menu, get_from_instr_db_menu(I_DB_CHOICE),
        put(12), call(I_DB_CHOICE).

display_instr_db_menu:- put(12), nl, tab(15), write('INSTRUCTOR DATABASE'),
        nl, nl, tab(15), write(' 1  Add'), nl, tab(15), write(' 2  Delete'),
        nl, tab(15), write(' 3  Quit'), nl, nl, tab(15),
        write(' Enter choice, 1. to 3.:  ').

get_from_instr_db_menu(I_DB_CHOICE):- read(CODE), transfer(CODE, I_DB_CHOICE),
        !.

transfer(1, add_instr).
transfer(2, delete_instr).
transfer(3, quit).
transfer(OTHER, correct_entry).

add_instr:- put(12), tab(15), write('  ADD INSTRUCTOR TO DATABASE '), nl, nl,
        tab(10), write(' Enter instructor name (or Q to quit):  '),
        read(NAME), do_add_instr(NAME).

do_add_instr(NAME):- (NAME = 'Q'; NAME = q), nl, nl, tab(5),
        write(' No instructor qualification has been entered.').
do_add_instr(NAME):- not(NAME = 'Q'), not (NAME = q), nl, tab(10),
        write(' Enter a segment qualification:  '), read(SEG), nl, tab(10),
        write(' Enter the segment qualification expiration date:  '),
        read(EXP_DATE), nl, nl, tab(5), write('Type "Y" to store '),
        write('information; "N" to quit without saving:  '), read(STORE),
        finish_add_instr( NAME, SEG, EXP_DATE, STORE), tab(5).

finish_add_instr(NAME, SEG, EXP_DATE, STORE):- (STORE = 'N'; STORE = 'n'),
        do_add_instr(q).
```

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```prolog
finish_add_instr( NAME, SEG, EXP_DATE, STORE):- not(STORE = 'N'),
        not(STORE = n), asserta(instructed_by(SEG, NAME, EXP_DATE)),
        nl, nl, tab(5), write('A qualification has been entered for '),
        write(NAME), write(' in the '), write(SEG), write(' stage.').

delete_instr:- put(12), tab(15), write('  DELETE INSTRUCTOR FROM DATABASE'),
        nl, nl, tab(10), write('Enter instructor name (or Q to quit):  '),
        read(NAME), ck_existence(NAME), !.

ck_existence(NAME):- instructed_by(SEG, NAME, DATE), nl, do_delete_instr(NAME).
ck_existence(NAME):- not(instructed_by(SEG, NAME, DATE)), nl, tab(5),
        write('No qualifications exist for '), write(NAME).

do_delete_instr(NAME):- (NAME = 'Q'; NAME = q), nl, tab(5),
        write('No instructor qualification has been deleted.').
do_delete_instr(NAME):- not(NAME = 'Q'), not (NAME = q), tab(5),
        write('Do you want to delete all segment qualifications for '),
        write(NAME), write('?(Y/N-or Q to quit.)  '),  read(ANS),
        finish_delete(NAME, ANS).

finish_delete(NAME, ANS):- (ANS = 'Q'; ANS = q), do_delete_instr(q).
finish_delete(NAME, ANS):- (ANS = 'Y'; ANS = y),
        doall(retract(instructed_by(SEG, NAME, EXP_DATE))), nl, nl, tab(5),
        write('All segment qualifications for '), write(NAME),
        write(' have been deleted.').
finish_delete(NAME, ANS):- (ANS = 'N'; ANS = n), nl, tab(10),
        write('Enter segment name:  '), read(SEG), retract(instructed_by(SEG,
        NAME, EXP_DATE)), nl, tab(10), write(SEG), write(' segment '),
        write('qualification for '), write(NAME), write(' has been removed.').
finish_delete(NAME, ANS):- not(ANS = 'Y'), not(ANS = y), not(ANS = 'N'),
        not(ANS = n), nl, tab(5),
        write('Incorrect Entry --  No action taken').

stud_db:- display_stud_db_menu, get_from_stud_db_menu(S_DB_CHOICE),
        put(12), call(S_DB_CHOICE).


        /*    makes changes to 'student' and 'completed' facts in database    */

display_stud_db_menu:- put(12), nl, tab(15), write('STUDENT DATABASE'), nl, nl,
        tab(15), write( ' 1  Add'), nl,
        tab(15), write( ' 2  Delete'), nl,
        tab(15), write( ' 3  Quit'), nl, nl,
        tab(15), write('Enter choice, 1. to 3.:  ').

get_from_stud_db_menu(S_DB_CHOICE):- read(CODE), opposite(CODE, S_DB_CHOICE),
        !.

opposite(1, add_stud).
opposite(2, delete_stud).
opposite(3, quit).
opposite(OTHER, correct_entry).

add_stud:- put(12), tab(10), write('  ADD STUDENT TO DATABASE'), repeat,
        do_add_stud(NAME), (NAME = 'Q'; NAME = q), !.

do_add_stud(NAME):- nl, nl, tab(10), write(' Enter student name '),
        write('(or Q to quit):  '), read(NAME), nl, nl, finish_add_stud(NAME).

finish_add_stud(NAME):- (NAME = 'Q'; NAME = q), nl, tab(5),
        write('No student was added.').
finish_add_stud(NAME):- not(NAME = 'Q'), not(NAME = q), asserta(student(NAME,
        0, 0, 0, 0)), tab(5), write(NAME),
        write(' has been added to the student'), write(' database.').
```

```
delete_stud:- put(12), tab(10), write('  DELETE STUDENT FROM DATABASE'),
        repeat, do_delete_stud(NAME), (NAME = 'Q'; NAME = q), !.

do_delete_stud(NAME):- nl, nl, tab(10), write('Enter student name '),
        write('(or Q to quit):  '), read(NAME), nl, nl,
        finish_delete_stud(NAME).

finish_delete_stud(NAME):- (NAME = 'Q'; NAME = q), nl, tab(5),
        write('No student was deleted').
finish_delete_stud(NAME):- not(NAME = 'Q'), not(NAME = q),
        doall(retract(completed(NAME, DATE, FLT, GRADE, TYPE, HRS))),
        retract(student(NAME, SIM_HRS, NT_HRS, AC_HRS, DATE_LAST_FLEW)),
        nl, tab(5), write(NAME), write(' has been deleted from the student'),
        write(' database.').

doall(PRED):- not(alltried(PRED)).
alltried(PRED):- call(PRED), fail.
```

```
/*******************************************************************/
/*      Module Name:   Snivel_log                                 */
/*      Purpose:       Provides data on when students and instructors are  */
/*                     unavailable to fly.  Used in making personnel changes  */
/*                     to the flight schedule                     */
/*******************************************************************/

snivel(crossv,900624,0001,1000).
snivel(pitzerg,900624,0600,1100).
snivel(sethj,900624,0900,1020).
snivel(wrightc,900624,0001,2400).
snivel(belloc,900624,730,1000).
snivel(mercurion,900624,800,1415).
snivel(sessip,900624,1030,2400).
snivel(haffent,900624,900,1000).
snivel(shattuckf,900624,1,2400).
```

```
/*******************************************************************/
/*      Module Name:   Update_snivel_log                          */
/*      Purpose:       Adds and deletes student/instructor 'unavailable'   */
/*                     periods.  Information entered from this module is    */
/*                     stored in the Snivel_log module            */
/*******************************************************************/


snivels:- display_snivel_menu, get_from_snivel_menu(SNIVEL_CHOICE),
        put(12), call(SNIVEL_CHOICE).

display_snivel_menu:- put(12), tab(15), write( ' SNIVELS' ), nl, nl,
                    tab(15), write( ' 1  Add to Snivel Log' ), nl,
                    tab(15), write( ' 2  Delete from Snivel Log' ), nl,
                    tab(15), write( ' 3  Change to Existing Snivel' ), nl,
                    tab(15), write( ' 4  Quit' ), nl, nl,
                    tab(15), write( 'Enter choice, 1 to 4:  ' ).

get_from_snivel_menu(SNIVEL_CHOICE):- read(CODE), interchange(CODE,
        SNIVEL_CHOICE), !.

interchange(1, add_snivel).
interchange(2, delete_snivel).
interchange(3, change_snivel).
interchange(4, quit).
interchange(OTHER, correct_entry).


        /*    adds snivel to snivel_log module    */

add_snivel:- tab(15), write('  Add to Snivel Log '), nl, nl,
        tab(10), write(' Enter student/instructor name (or Q to quit):  '),
        read(NAME), nl, do_add_snivel(NAME).

do_add_snivel(NAME):- (NAME = 'Q'; NAME = q), nl, tab(10),
        write('No snivel was entered.').
do_add_snivel(NAME):- not(NAME = 'Q'), not(NAME = q),
        tab(10), write(' Enter snivel date:  '), read(DATE), nl,
        tab(10), write(' Enter log-out time:  '), read(CK_OUT), nl,
        tab(10), write(' Enter log-in time:  '), read(CK_IN , nl,
        asserta(snivel(NAME, DATE, CK_OUT, CK_IN)), nl, nl, tab(5),
        write(NAME), write(' has been entered in the Snivel Log for the'),
        write(' period '), nl, tab(10), write(DATE), write(' from '),
        write(CK_OUT), write(' to '), write(CK_IN), write('.').


        /*    deletes snivel from snivel_log module    */

delete_snivel:- tab(15), write(' Delete from Snivel Log '), nl, nl,
        tab(10), write(' Enter student/instructor name (or Q to quit):  '),
        read(NAME), nl, do_delete_snivel(NAME).

do_delete_snivel(NAME):- (NAME = 'Q'; NAME = q), nl, tab(10),
        write('No snivel was deleted.').
do_delete_snivel(NAME):- not(NAME = 'Q'), not(NAME = q),
        tab(10), write(' Enter snivel date:  '), read(DATE), nl,
        find_existing_snivel(NAME, DATE, CK_OUT, CK_IN, EXISTS), !,
        finish_delete(NAME, DATE, CK_OUT, CK_IN, EXISTS), !.
```

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```
find_existing_snivel(NAME, DATE, CK_OUT, CK_IN, EXISTS):-
        snivel(NAME, DATE, CK_OUT, CK_IN), EXISTS is 1,
        tab(10), write(' Log-out time:  '), write(CK_OUT), nl,
        tab(10), write(' Log-in time :  '), write(CK_IN), nl, nl.
find_existing_snivel(NAME, DATE, CK_OUT, CK_IN, EXISTS):-
        EXISTS is 0, write('No snivel exists for '),
        write(NAME), write(' on '), write(DATE), write('.').


finish_delete(NAME, DATE, CK_OUT, CK_IN, EXISTS):- EXISTS = 0.
finish_delete(NAME, DATE, CK_OUT, CK_IN, EXISTS):- EXISTS = 1,
        tab(10), write(' Do you want to delete this?(Y/N)  '), read(ANS),
        ck_delete( NAME, DATE, CK_OUT, CK_IN, ANS).

ck_delete(NAME, DATE, CK_OUT, CK_IN, ANS):- (ANS = 'N'; ANS = 'n').
ck_delete(NAME, DATE, CK_OUT, CK_IN, ANS):- (ANS = 'Y'; ANS = 'y'),
        retract(snivel(NAME, DATE, CK_OUT, CK_IN)), nl, nl,
        write(NAME), write(' has been deleted from the Snivel Log for the'),
        write(' period '), nl, tab(5), write(DATE), write(' from '),
        write(CK_OUT), write(' to '), write(CK_IN), write('.').



     /*    changes existing snivel in snivel_log module    */

change_snivel:- tab(15), write(' Change an Existing Snivel '), nl, nl,
        tab(10), write(' Enter student/instructor name (or Q to quit):  '),
        read(NAME), nl, do_change_snivel(NAME).

do_change_snivel(NAME):- (NAME = 'Q'; NAME = q), nl, tab(10),
        write('No snivel was changed.').
do_change_snivel(NAME):- not( NAME = 'Q'), not(NAME = q),
        tab(10), write(' Enter snivel date:  '), read(DATE), nl,
        find_existing_snivel(NAME, DATE, CK_OUT, CK_IN, EXISTS), !,
        finish_change(NAME, DATE, CK_OUT, CK_IN, EXISTS), !.

finish_change(NAME, DATE, CK_OUT, CK_IN, EXISTS):- EXISTS = 0.
finish_change(NAME, DATE, CK_OUT, CK_IN, EXISTS):- EXISTS = 1,
        write( 'Do you want to change the Date(D), Log-out time(O),'),
        write('Log-in time(I)'), nl, write(' or Return to Main Menu(R)?  '),
        read( I_O ), do_snivel_changes(NAME, DATE, CK_OUT, CK_IN, I_O).

do_snivel_changes(NAME, DATE, CK_OUT, CK_IN, I_O):- (I_O = 'R'; I_O = r).
do_snivel_changes(NAME, DATE, CK_OUT, CK_IN, I_O):- (I_O = 'D'; I_O = d),
        retract(snivel(NAME, DATE, CK_OUT, CK_IN)),
        tab(10), write('What is the new snive. date:  '), read(NEW_DATE),
        asserta(snivel(NAME, NEW_DATE, CK_OUT, CK_IN)), nl, tab(10),
        write(' The new snivel period for '), write(NAME),
        write(' is '), nl, tab(15), write(NEW_DATE), write(' from '),
        write(CK_OUT), write(' to '), write(CK_IN), write('.').

do_snivel_changes(NAME, DATE, CK_OUT, CK_IN, I_O):- (I_O = 'O'; I_O = o),
        retract(snivel(NAME, DATE, CK_OUT, CK_IN)),
        tab(10), write('What is the new Log-out time?  '), read(NEW_OUT),
        asserta(snivel(NAME, DATE, NEW_OUT, CK_IN)), nl, tab(10),
        write(' The new snivel period for '), write(NAME),
        write(' is '), nl, tab(15), write(DATE), write(' from '),
        write(NEW_OUT), write(' to '), write(CK_IN).

do_snivel_changes(NAME, DATE, CK_OUT, CK_IN, I_O):- (I_O = 'I'; I_O = i),
        retract(snivel(NAME, DATE, CK_OUT, CK_IN)),
        tab(10), write('What is the new Log-in time?  '), read(NEW_IN),
        asserta(snivel( NAME, DATE, CK_OUT, NEW_IN)), nl, tab(10),
        write(' The new snivel period for '), write(NAME),
        write(' is '), nl, tab(15), write(DATE), write(' from '),
        write(CK_OUT), write(' to '), write(NEW_IN).
```

```
/******************************************************************************/
/*      Module Name:  Change_personnel                                       */
/*      Purpose:      To make changes to an existing flight schedule.        */
/*                    Uses the "actual flight schedule" and "snivel_log"      */
/*                    modules to make changes in students and instructors     */
/******************************************************************************/


changes:- display_change_menu, get_from_changes(CHANGE_CHOICE),
        put(12), call(CHANGE_CHOICE).

display_change_menu:- put(12), nl, tab(15), write('CHANGE PERSONNEL'), nl,
        nl, tab(15), write( ' 1   Change Instructor' ), nl,
        tab(15), write( ' 2   Change Student'), nl,
        tab(15), write( ' 3   Quit'), nl, nl,
        tab(15), write( 'Enter choice, 1 to 3:  ' ).

get_from_changes(CHANGE_CHOICE):- read(CODE),
        translate(CODE, CHANGE_CHOICE), !.

translate(1, change_instr).
translate(2, change_stud).
translate(3, quit).
translate(OTHER, correct_entry).


        /*  makes changes to the instructor  */

change_instr :- nl, nl, tab(10), write('Enter instructor name:  '),
        read(INSTR_NAME), add_to_snivels(INSTR_NAME), bagof([EVT, SQDN,
        STUD_NAME, INSTR_NAME, FLIGHT, TIME, ETE, RMKS], sked(EVT, SQDN,
        STUD_NAME, INSTR_NAME, FLIGHT, TIME, ETE, RMKS), SKED_LIST), nl, nl,
        tab(5), write('Searching . . .'), process_missed_flights(SKED_LIST),
        nl, tab(15), write('All flights for '), write(INSTR_NAME),
        write(' have been adjusted.').

add_to_snivels(NAME):- nl, nl, tab(10), write('Enter log-out time:  '),
        read( CK_OUT), nl, nl, tab(10), write('Enter log-in time:  '),
        read(CK_IN), date(DATE), asserta(snivel(NAME, DATE, CK_OUT, CK_IN)),
        nl, nl, tab(5), write(NAME), write(' has been entered in the '),
        write('Snivel Log for the period '), nl, tab(5), write(DATE),
        write(' from '), write(CK_OUT), write(' to '), write(CK_IN),
        write('.').

process_missed_flights([]).
process_missed_flights([[EVT, SQDN, STUD, INSTR, FLT, TIME, ETE,
        RMKS]|SKED_LIST]) :- date(DATE), snivel(INSTR, DATE,
        CK_OUT, CK_IN), TIME < (CK_IN + 100), not(TIME < (CK_OUT - 300)),
        retract(sked(EVT, SQDN, STUD, INSTR, FLT, TIME, ETE, RMKS)),
        (find_authorized_instructor(EVT, SQDN, STUD, INSTR, FLT, TIME,
        ETE, RMKS); change_flt(EVT, SQDN, STUD, INSTR, FLT, TIME);
        resked_time(EVT, S  N, STUD, INSTR, FLT, TIME)),
        process_missed_flights(SKED_LIST).
process_missed_flights([[EVT, SQDN, STUD, INSTR, FLT, TIME, ETE,
        RMKS]|SKED_LIST]) :- date(DATE), snivel(INSTR, DATE, CK_OUT,
        CK_IN), (TIME < (CK_OUT - 300); TIME > (CK_IN + 100)),
        process_missed_flights(SKED_LIST).


find_authorized_instructor(EVT, SQDN, STUD, INSTR, FLT, TIME, ETE, RMKS) :-
```

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```prolog
            segment(SEG, FLT, TYPE), bagof(INSTR_NAME,
            EXP_DATE^instructed_by(SEG, INSTR_NAME, EXP_DATE), POSSIBLES), nl,
            process_possible_substitutes(EVT, SQDN, STUD, INSTR, FLT, TIME,
            ETE, RMKS, POSSIBLES).

process_possible_substitutes(EVT, SQDN, STUD, INSTR, FLT, TIME, ETE, RMKS,
            POSSIBLES) :-
            check_pt_times(TIME, T1, T2), member(SUB, POSSIBLES),
            not(instr_sked(SUB, T1, T2)), asserta(sked(EVT, SQDN, STUD, SUB,
            FLT, TIME, ETE, RMKS)).


check_pt_times(TIME, T1, T2):- TIME > 0900, TIME < 2000, T1 is (TIME - 300),
            T2 is (TIME + 300).

check_pt_times(TIME, T1, T2):- TIME < 0930, T1 is 0600, T2 is (TIME + 300).

check_pt_times(TIME, T1, T2):- TIME > 1930, T1 is (TIME - 300), T2 is 2300.

instr_sked(SUB, T1, T2):- (bagof(TIME,
            EVT^SQDN^STUD^FLT^ETE^RMKS^sked(EVT, SQDN, STUD, SUB, FLT, TIME,
            ETE, RMKS), SUBS_SKED), conflict( SUB, SUBS_SKED, T1, T2 ));
            snivelled(SUB, T1, T2).

conflict(SUB, SUBS_SKED, T1, T2):- snivelled(SUB, T1, T2);
            member(T, SUBS_SKED), overlap(T, T1, T2).

snivelled(SUB, T1, T2):- date(DATE), snivel(SUB, DATE, CK_OUT, CK_IN),
            CK_OUT < T2, not(CK_IN < T1).

overlap(T, T1, T2):- T > T1, T < T2.


    /*  to find another flight the student is qualified for        */
    /*  that an instructor is available to teach at the sked time.  */


change_flt( EVT, SQDN, STUD, INSTR, FLT, TIME ):-
        (bagof( NEW_FLT, ck_doables( NEW_FLT, STUD, TIME ), POSSIBLE_FLTS );
        bagof( NEW_FLT, ck_prereqs( NEW_FLT, STUD ), POSSIBLE_FLTS )),
        process_possible_flights( POSSIBLE_FLTS, EVT, SQDN, STUD, INSTR, FLT,
        TIME ).

ck_doables(NEW_FLT, STUD, TIME):- doable(NEW_FLT, STUD, TIME),
        (not(completed(STUD, DATE, NEW_FLT, TYPE, GRADE));
        (completed(STUD, DATE, NEW_FLT, TYPE, GRADE), GRADE = u,
        not(successful_completion(STUD, DATE, NEW_FLT, TYPE, GRADE)))).

successful_completion(STUD, DATE, NEW_FLT, TYPE, GRADE):-
        completed(STUD, ANY_DATE, NEW_FLT, TYPE, GRADE), not(GRADE = u).

ck_prereqs(NEW_FLT, STUD):-
        prereq( NEW_FLT, FLT_DONE ),
        (not(completed(STUD, DATE, NEW_FLT, TYPE, GRADE));
        (completed(STUD, DATE, NEW_FLT, TYPE, GRADE), GRADE = u,
        not(successful_completion(STUD, DATE, NEW_FLT, TYPE, GRADE)))),
        successful_completion(STUD, DATE2, FLT_DONE, TYPE2, GRADE2).

process_possible_flights( [], EVT, SQDN, STUD, INSTR, FLT, TIME ).
process_possible_flights( POSSIBLE_FLTS, EVT, SQDN, STUD, INSTR, FLT,
        TIME ):-
        member( NEW_FLT, POSSIBLE_FLTS ), segment( NEW_SEG, NEW_FLT,
        NEW_TYPE), do_processing( EVT, SQDN, STUD, INSTR, FLT, TIME,
        NEW_SEG, NEW_FLT, NEW_TYPE).
```

```
do_processing(EVT, SQDN, STUD, INSTR, FLT, TIME, SEG, NEW_FLT, TYPE):-
        TYPE = s, duration(NEW_FLT, ETE), asserta(sked(EVT, SQDN, STUD,
        sim, NEW_FLT, TIME, ETE, '2F90')).
do_processing(EVT, SQDN, STUD, INSTR, FLT, TIME, SEG, NEW_FLT, TYPE):-
        TYPE = p, segment(OLD_SEG, FLT, TYPE), not(SEG = OLD_SEG),
        flight_duration(NEW_FLT, ETE), find_authorized_instructor(EVT,
        SQDN, STUD, INSTR, NEW_FLT, TIME, ETE, *).


    /*   completely reschedules the time period   */

resked_time( EVT, SQDN, STUD, INSTR, FLT, TIME ):-
        get_sked_list( SKED_STUDS), get_stud_dates( FLEW_DATES ),
        member(FIRST_DATE, FLEW_DATES), bagof(NAME,
        SIM_HRS^NT_HRS^AC_HRS^student(NAME, SIM_HRS, NT_HRS, AC_HRS,
        FIRST_DATE), READY_STUDS), sked_flight(READY_STUDS, SKED_STUDS,
        EVT, SQDN, INSTR, FLT, TIME ).

get_sked_list( SKED_STUDS ):- bagof( STUD_NAME,
        EVTS^SQDNS^INSTRS^FLTS^TIMES^ETES^RMKSS^sked( EVTS, SQDNS,
        STUD_NAME, INSTRS, FLTS, TIMES, ETES, RMKSS), SKED_STUDS).

get_stud_dates( FLEW_DATES ):- setof( DATE_LAST_FLEW,
        STUD_NAME^SIM_HRS^NT_HRS^AC_HRS^student( STUD_NAME, SIM_HRS, NT_HRS,
        AC_HRS, DATE_LAST_FLEW ), FLEW_DATES ).

sked_flight( READY_STUDS, SKED_STUDS, EVT, SQDN, INSTR, FLT, TIME ):-
        check_pt_times( TIME, T1, T2 ), member( STUDENT, READY_STUDS ),
        not( member( STUDENT, SKED_STUDS ) ),
        not( snivelled(STUDENT, T1, T2) ),
        change_flt( EVT, SQDN, STUDENT, INSTR, FLT, TIME ).


    /*   to change student   */

change_stud:- nl, nl, tab(10),
        write('Enter student name:  '), read( STUD_NAME ),
        add_to_snivels(STUD_NAME), bagof( [EVT, SQDN, INSTR_NAME, FLIGHT,
        TIME, ETE, RMKS], sked( EVT, SQDN, STUD_NAME, INSTR_NAME, FLIGHT,
        TIME, ETE, RMKS ), STUD_SKED_LIST ), nl, nl, tab(5),
        write('Searching . . .'),
        process_changing_flights( STUD_SKED_LIST, STUD_NAME ),
        nl, tab(15), write('All flights for '), write(STUD_NAME),
        write(' have been adjusted.').

process_changing_flights( [], STUD ).
process_changing_flights( [ [EVT, SQDN, INSTR, FLT, TIME, ETE, RMKS]|
        STUD_SKED_LIST ], STUD):- date(DATE), snivel(STUD, DATE, CK_OUT,
        CK_IN), TIME < (CK_IN + 100), not(TIME < (CK_OUT - 300)),
        retract(sked(EVT, SQDN, STUD, INSTR, FLT, TIME, ETE, RMKS)),
        (find_eligible_student(EVT, SQDN, STUD, INSTR, FLT, TIME, ETE, RMKS);
        find_new_flt( EVT, SQDN, STUD, INSTR, FLT, TIME );
        resked_time( EVT, SQDN, STUD, INSTR, FLT, TIME )),
        process_changing_flights( STUD_SKED_LIST, STUD ).

find_eligible_student(EVT, SQDN, STUD, INSTR, FLT, TIME, ETE, RMKS):-
        get_sked_list(SKED_STUDS), get_stud_dates(FLEW_DATES),
        member(FIRST_DATE, FLEW_DATES), bagof(NAME,
        SIM_HRS^NT_HRS^AC_HRS^student(NAME, SIM_HRS, NT_HRS, AC_HRS,
        FIRST_DATE), READY_STUDS), sked_replacement(READY_STUDS,
        SKED_STUDS, EVT, SQDN, STUD, INSTR, FLT, TIME, ETE, RMKS ).


sked_replacement(READY_STUDS, SKED_STUDS, EVT, SQDN, STUD, INSTR, FLT, TIME,
```

```prolog
       ETE, RMKS):-
       check_pt_times(TIME, T1, T2), member(STUDENT, READY_STUDS),
       not(member(STUDENT, SKED_STUDS)), date(DATE),
       not(snivelled(STUDENT, T1, T2)), (ck_doables(FLT, STUDENT,
       TIME); ck_prereqs(FLT, STUDENT)), asserta(sked(EVT, SQDN, STUDENT,
       INSTR, FLT, TIME, ETE, RMKS)).


    /*  to find a student who is eligible to fly a flight the  */
    /*  instructor is qualified to teach                       */

find_new_flt(EVT, SQDN, STUD, INSTR, FLT, TIME):-
       get_sked_list(SKED_STUDS), get_stud_dates(FLEW_DATES),
       member(FIRST_DATE, FLEW_DATES), bagof(NAME,
       SIM_HRS^NT_HRS^AC_HRS^student(NAME, SIM_HRS, NT_HRS,
       AC_HRS, FIRST_DATE), READY_STUDS), do_new_flt(READY_STUDS,
       SKED_STUDS, EVT, SQDN, STUD, INSTR, FLT, TIME).

do_new_flt(READY_STUDS, SKED_STUDS, EVT, SQDN, STUD, INSTR, FLT,
       TIME):- bagof(SEG_NAME, EXP_DATE^instructed_by(SEG_NAME, INSTR,
       EXP_DATE), SEG_LIST), check_pt_times(TIME, T1, T2),
       member(FIRST_STUD, READY_STUDS), not(member(FIRST_STUD, SKED_STUDS)),
       not(snivelled(FIRST_STUD, T1, T2)), (bagof(NEW_FLT,
       ck_doables(NEW_FLT, FIRST_STUD, TIME), POSSIBLE_FLTS);
       bagof(NEW_FLT, ck_prereqs(NEW_FLT, FIRST_STUD), POSSIBLE_FLTS)),
       segment(SEG, FLT, TYPE), member(NEW_FLT, POSSIBLE_FLTS),
       check_type(SEG_LIST, NEW_FLT, EVT, SQDN, FIRST_STUD, INSTR, TIME,
       TYPE).

check_type(SEG_LIST, NEW_FLT, EVT, SQDN, NEW_STUD, INSTR, TIME, TYPE):-
       TYPE = s, segment(NEW_SEG, NEW_FLT, NEW_TYPE), NEW_TYPE = s,
       flight_duration(NEW_FLT, ETE), asserta(sked(EVT, SQDN, NEW_STUD,
       sim, NEW_FLT, TIME, ETE, '2F90')).
check_type(SEG_LIST, NEW_FLT, EVT, SQDN, NEW_STUD, INSTR, TIME, TYPE):-
       TYPE = p, segment(NEW_SEG, NEW_FLT, NEW_TYPE), NEW_TYPE = p,
       member(NEW_SEG, SEG_LIST), flight_duration(NEW_FLT, ETE),
       asserta(sked(EVT, SQDN, NEW_STUD, INSTR, NEW_FLT, TIME, ETE, *)).

delete(X, [], []).
delete(X, [X|L1], L2):- delete(X, L1, L2).
delete(X, [Y|L1], [Y|L2]):- not(X = Y), delete(X, L1, L2).

member(X, [X|L]).
member(X, [Y|L]):- member(X, L).
```

```
/*******************************************************************************/
/*      Module Name:    Print                                                  */
/*      Purpose:        Prints the flight schedule                             */
/*******************************************************************************/


print_flight_schedule :- put(12), date(SKED_DATE),
                         tab(30), write('FLIGHT SCHEDULE'), nl,
                         tab(33), write(SKED_DATE), nl, nl, print_titles,
                         print_times, nl, write('Press any key to continue.'),
                         read( ANYKEY ).

print_titles :- nl, write('EVT :SQDN :T/O :INSTRUCTOR  :STUDENT      :'),
         write('FLIGHT :ETE :SIDE # :D/S :TY  :HRS :I/C :REMARKS').

print_times:-foriterate( print_events_at_same_time, 48 ).

foriterate( PRED, N ):- asserta( counter(0) ), repeat, counter( K ),
   K2 is K+1, retract( counter( K ) ),
   asserta( counter( K2 ) ), iterate2( PRED ),
   K2 >= N, retract( counter( K2 ) ), !.

iterate2( PRED ):- call(PRED),  !.
iterate2( PRED ).

print_events_at_same_time :- print_one_time, fail.

print_one_time:- counter(K), K<7, 0 is K mod 2,
                 TIME is ((((K/2)+6)*100)+30+((K-1)*5)), print_line(TIME).

print_one_time:- counter(K), K<12, 1 is K mod 2,
                 TIME is (((((K+1)/2)+6)*100)+((K-1)*5)), print_line(TIME).

print_one_time:- counter(K), K>7, K<19, 0 is K mod 2,
                 TIME is ((((K/2)+7)*100)+((K-7)*5)), print_line(TIME).

print_one_time:- counter(K), K>12, K<24, 1 is K mod 2,
                 TIME is (((((K+1)/2)+7)*100)+((K-13)*5)), print_line(TIME).

print_one_time:- counter(K), K>19, 0 is K mod 2,
                 TIME is ((((K/2)+8)*100)+((K-19)*5)), print_line(TIME).

print_one_time:- counter(K), K>24, 1 is K mod 2,
                 TIME is (((((K+1)/2)+8)*100)+((K-25)*5)), print_line(TIME).

print_line(TIME) :-
    sked(EVT, SQDN, STUD_NAME, INSTR_NAME, FLT, TIME, ETE, REMARKS ),
    nl,
    figure_spacing(EVT, 3), write(EVT), write(' : '), write(SQDN),
    write(' :'), figure_spacing(TIME, 4), write(TIME),
    write(':'), write(INSTR_NAME), figure_spacing(INSTR_NAME, 12), write(':'),
    write(STUD_NAME), figure_spacing(STUD_NAME, 12), write(':'), write(FLT),
    figure_spacing(FLT, 7), write(':'), write(ETE), figure_spacing(ETE, 3),
    write(' :_____:____:____:____:____:'), write(REMARKS).

figure_spacing(ITEM, FIELD):- name(ITEM, L), length(L, N),
         SPACE is (FIELD - N), CNTR is 0, put_spaces(SPACE, CNTR).

put_spaces(SPACE, CNTR):- not(CNTR < SPACE).
```

```
/***************************************************************************/
/*      Module Name:   Completions                                      */
/*      Purpose:       Records completions of student flights in the    */
/*                     "completed" fact type and adjusts total number   */
/*                     of simulator, night, and aircraft hours in the   */
/*                     "student" fact type.                             */
/***************************************************************************/


completions:- put(12), tab(15), write('  RECORD COMPLETIONS'), nl, nl, nl,
        bagof([STUD, FLT, TIME], EVT^SQDN^INSTR^ETE^RMKS^sked(EVT,SQDN,
        STUD, INSTR, FLT, TIME, ETE, RMKS), NEW_COMPLETES),
        do_completion(NEW_COMPLETES).


do_completion([]).
do_completion([[STUD, FLT, TIME]|NEW_COMPLETES]):- nl, nl, tab(5),
        write('Enter the actual number of flight hours for '), write(STUD),
        write('''s '), write(TIME), write(' '), write(FLT), write(' flight '),
        nl, tab(10), write('(or Q if not completed):  '), read(HOURS),
        finish_completion(STUD, FLT, HOURS, TIME),
        do_completion(NEW_COMPLETES).

finish_completion(STUD,FLT, HOURS, TIME):- (HOURS = 'Q'; HOURS = q).
finish_completion(STUD, FLT, HOURS, TIME):- not(HOURS = 'Q'), not(HOURS = q),
        nl, tab(5), write('Enter the grade received, i.e., aa, a, ba, u '),
        write('(or Q to quit):  '), read(GRADE), final_completion(STUD, FLT,
        HOURS, GRADE, TIME).

final_completion(STUD, FLT, HOURS, GRADE, TIME):- (GRADE = 'Q'; GRADE = q),
        nl, tab(5), write('No completion was recorded.').
final_completion(STUD, FLT, HOURS, GRADE, TIME):- not(GRADE = 'Q'),
        not(GRADE = q), date(DATE), segment(SEG, FLT, TYPE), add_flight(STUD,
        FLT, HOURS, TIME, GRADE, TYPE), nl, tab(10),
        write('Completion has been recorded.').


add_flight(STUD, FLT, HOURS, TIME, GRADE, TYPE):- TYPE = s, date(DATE),
        asserta(completed(STUD, DATE, FLT, s, GRADE)),
        student(STUD, SIM_HRS, NT_HRS, AC_HRS, DATE_LAST_FLEW), NEW_SIM_HRS
        is SIM_HRS + HOURS, retract(student(STUD, SIM_HRS, NT_HRS, AC_HRS,
        DATE_LAST_FLEW)), date(DATE), asserta(student(STUD, NEW_SIM_HRS,
        NT_HRS, AC_HRS, DATE)).


add_flight(STUD, FLT, HOURS, TIME, GRADE, TYPE):- TIME > NIGHT, not(TYPE = s),
        asserta(completed(STUD, DATE, FLT, n, GRADE)),student(STUD, SIM_HRS,
        NT_HRS, AC_HRS, DATE_LAST_FLEW), NEW_NT_HRS is NT_HRS + HOURS,
        NEW_AC_HRS is AC_HRS + HOURS, retract(STUD, SIM_HRS, NT_HRS, AC_HRS,
        DATE_LAST_FLEW), date(DATE), asserta(student(STUD, SIM_HRS,
        NEW_NT_HRS, NEW_AC_HRS, DATE)).


add_flight(STUD, FLT, HOURS, TIME, GRADE, TYPE):- not(TIME > NIGHT),
        not(TYPE = s), asserta(completed(STUD, DATE, FLT, d, GRADE)),
        student(STUD, SIM_HRS, NT_HRS, AC_HRS, DATE_LAST_FLEW), NEW_AC_HRS is
        AC_HRS + HOURS, retract(student(STUD, SIM_HRS, NT_HRS, AC_HRS,
        DATE_LAST_FLEW)), date(DATE), asserta(student(STUD, SIM_HRS, NT_HRS,
        NEW_AC_HRS, DATE)).
```

```
put_spaces(SPACE, CNTR):- CNTR < SPACE, write(' '), CNTR2 is (CNTR + 1),
        put_spaces(SPACE, CNTR2).
```

APPENDIX B

ACTUAL FLIGHT SCHEDULE MODULE

This module is independent of the rescheduling program. A separate file exists for each flight schedule and can be accessed by the program as the user desires. The program will question the user for the file he wants to work with if none is currently being used, or the option exists for the user to change working files from inside the program.

```
/******************************************************************/
/*      Module Name:    Actual flight schedule                    */
/*      Purpose:        Provides the data changes are made upon and the data    */
/*                      to arrive at completion information        */
/******************************************************************/


filename(skedfacts).

date(900624).

sunset(2046).

sked(1,22,mendiolam,sim,ri3s,700,2,'2F90').
sked(1,22,thienep,sim,bi4s,700,2,'2F90').
sked(2,22,oehlert,zarchya,ri15x,735,1.5,*).
sked(2,22,chankleg,sim,ri11xs,735,2,'2F90').
sked(3,22,millerc,rolloww,an7,810,1.6,*).
sked(3,22,zogers,crossmana,fam2,810,1.4,*).
sked(4,22,clinek,hiltonc,fam3,845,1.4,*).
sked(4,22,harrowb,fletcherj,fam8,845,1.4,*).
sked(5,22,vanekc,nordeen,form2x,920,1.4,'w/21').
sked(5,22,huffw,waltersa,tacf1,920,1.4,*).
sked(6,22,lambb,paparoj,ocf3,955,0.8,*).
sked(6,22,xet,bussmannl,acm6x,955,1.1,*).
sked(7,22,bradleyw,patrickm,ocf3,1030,1.1,*).
sked(7,22,jonesh,merilosl,acm13,1030,1.2,*).
sked(8,22,garciae,hulsed,acm11x,1105,1.2,*).
sked(8,22,taffp,seymourw,acm13,1105,1.2,*).
sked(9,22,glasurep,garreltsb,bi9,1140,1.4,*).
sked(9,22,leckiew,sim,co7s,1140,2,'2F90').
sked(10,22,tigarb,mesmerk,fam6,1215,1.4,*).
sked(10,22,leetchk,crossv,fam2,1215,1.4,*).
sked(11,22,aasena,gallaghers,form4x,1250,1.4,'w/21').
sked(11,22,burrt,pitzerg,on5x,1250,1.4,*).
sked(12,22,healdh,myerss,on4,1325,1.5,*).
sked(12,22,cruzb,sessip,acm13,1325,1.2,*).
sked(13,22,farquharsonp,sim,bi7s,1400,2,'2F90').
sked(13,22,mcclured,hatteryk,bi10x,1400,1.4,*).
sked(14,22,spagnoloe,hiltonc,ri15x,1435,1.5,*).
sked(14,22,simona,sim,co7s,1435,2,'2F90').
sked(15,22,gangia,crossmana,fam5,1510,1.4,*).
sked(15,22,tigarc,johnsons,form3,1510,1.4,'w/21 ').
sked(16,22,finleyy,waltersa,tacf2,1545,1.4,*).
sked(16,22,bello,rolloww,acm1,1545,1.1,*).
sked(17,22,bakerk,nordeen,acm5,1620,1.1,*).
sked(17,22,atkinsonm,sim,bi6s,1620,2.0,'2F90').
sked(26,22,curryy,maurerw,nf2,2135,0.8,*).
sked(26,22,beavenr,boronkay,nf1,2135,1.4,*).
sked(27,22,aasena,johnsons,nf1,2210,1.4,*).
sked(27,22,bakerk,bruruda,acm5,2210,1.1,*).
```

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APPENDIX C

DATABASE MODULE

This module contains the supporting facts and rules needed by the program to execute.

```
/******************************************************************/
/*      Module Name:  Database                                  */
/*      Purpose:      Provides the facts needed to execute changes to a   */
/*                    flight schedule.                          */
/******************************************************************/


student( curryy, 60.02, 1.4, 35.24, 900614 ).
student( bello, 66.02, 16.4, 76.89, 900618 ).
student( beavenr, 60.02, 0, 32.44, 900622 ).
student( ashcrafth, 32.02, 0, 2.8, 900618 ).
student( andrewss, 40.02, 0, 2.8, 900617 ).
student( healdh, 62.02, 10.1, 48.06, 900615 ).
student( harrowb, 58.02, 0, 25.4, 900615 ).
student( oehlert, 48.02, 0, 7, 900616 ).
student( chankleg, 42.02, 0, 2.8, 900619 ).
student( sextonb, 56.02, 0, 13.3, 900616 ).
student( tigarc, 60.02, 0, 29.62, 900622 ).
student( tigarb, 58.02, 0, 22.6, 900619 ).
student( thienep, 8, 0, 0, 900621 ).
student( zapantan, 14.2, 0, 0, 900617 ).
student( xet, 66.02, 26, 82.39, 900613 ).
student( glasurep, 22.2, 0, 0, 900619 ).
student( mendiolam, 26.2, 0, 3.3, 900621 ).
student( petersonf, 14.02, 0, 0, 900615 ).
student( romanoe, 44.02, 0, 2.8, 900614 ).
student( rivetteg, 26.02, 0, 3.1, 900620 ).
student( sewellt, 56.02, 0, 19.4, 900621 ).
student( zoelline, 26.02, 0, 2.8, 900613 ).
student( zogers, 56.02, 0, 18, 900613 ).
student( vanekc, 60.02, 0, 28.22, 900621 ).
student( pedicords, 20.2, 0, 0, 900618 ).
student( quinnw, 56.02, 0, 20.8, 900622 ).
student( millerc, 56.02, 0, 10.1, 900618 ).
student( leetchk, 56.02, 0, 18, 900620 ).
student( leckiew, 54.02, 0, 10.1, 900615 ).
student( huffw, 62.02, 20.2, 50.97, 900622 ).
student( hotariej, 26.2, 0, 2.6, 900618 ).
student( gangia, 58.02, 0, 21.2, 900615 ).
student( benechd, 22.02, 0, 3.0, 900613 ).
student( aasena, 60.02, 0, 31.04, 900618 ).
student( clinek, 56.02, 0, 19.4, 900613 ).
student( heltonr, 54.02, 0, 8.5, 900620 ).
student( ladelfaj, 26.02, 0, 3.0, 900615 ).
student( ogawas, 48.02, 0, 8.5, 900614 ).
student( oberbeckl, 32.02, 0, 2.8, 900615 ).
student( ratliffh, 48.02, 0, 7, 900615 ).
student( shagerl, 56.02, 0, 11.7, 900617 ).
student( elisonj, 50.02, 0, 8.5, 900621 ).
student( westb, 66.02, 18, 79.09, 900619 ).
student( morleyc, 50.02, 0, 8.5, 900618 ).
student( burrt, 62.02, 12, 49.7, 900614 ).
student( hendersonl, 26.02, 0, 2.7, 900617 ).
student( simona, 54.02, 0, 10.1, 900619 ).
student( macdougalls, 22.02, 0, 3.1, 900617 ).
student( lobdellj, 30.02, 0, 2.8, 900619 ).
student( belloc, 62.02, 15.6, 55.19, 900618 ).
student( harrisp, 52.02, 0, 8.5, 900612 ).
student( lambb, 66.02, 15.9, 76.09, 900618 ).
```

```
student( bakerk, 66.02, 29.6, 81.29, 900613 ).
student( spagnoloe, 44.02, 0, 7, 900622 ).
student( yeagers, 44.02, 0, 8.5, 900614 ).
student( atkinsonm, 12, 0, 0, 900616 ).
student( finleyy, 62.02, 9.63, 52.37, 900620 ).
student( jonesh, 66.02, 24.3, 90.99, 900613 ).
student( farquharsonp, 16.2, 0, 0, 900616 ).
student( mcclured, 22.2, 0, 1.6, 900614 ).
student( maxwelll, 6, 0, 0, 900621 ).
student( oefeleini, 4, 0, 0, 900614 ).
student( strasserp, 2, 0, 0, 900622 ).
student( cruzb, 66.02, 24.5, 92, 900616 ).
student( wrightc, 66.02, 20, 88.59, 900615 ).
student( sethj, 66.02, 17.9, 90.99, 900617 ).
student( taffp, 66.02, 17.1, 93, 900619 ).
student( bradleyw, 66.02, 16.6, 76.09, 900619 ).
student( garciae, 66.02, 20.3, 87.99, 900622 ).
student( lordg, 66.02, 16.4, 86.79, 900618 ).


instructed_by( ri, burgan, 900624 ).
instructed_by( fam, crossmana, 900917 ).
instructed_by( form, crossmana, 900807 ).
instructed_by( fam, seymourw, 900914 ).
instructed_by( acm, seymourw, 900907 ).
instructed_by( cq, seymourw, 901015 ).
instructed_by( fam, zarchya, 900730 ).
instructed_by( form, zarchya, 900815 ).
instructed_by( ri, zarchya, 900916 ).
instructed_by( fam, zupicj, 901101 ).
instructed_by( nf, zupicj, 901118 ).
instructed_by( form, abalonettic, 910320 ).
instructed_by( nf, abalonettic, 910331 ).
instructed_by( form, hulsed, 910616 ).
instructed_by( acm, hulsed, 900715 ).
instructed_by( cq, hulsed, 900717 ).
instructed_by( nf, mercurion, 910530 ).
instructed_by( acm, mercurion, 910531 ).
instructed_by( nf, merilosl, 900912 ).
instructed_by( acm, merilosl, 900915 ).
instructed_by( cq, merilosl, 900930 ).
instructed_by( acm, sessip, 901016 ).
instructed_by( cq, sessip, 901103 ).
instructed_by( fam, hiltonc, 900716 ).
instructed_by( form, hiltonc, 900718 ).
instructed_by( ri, hiltonc, 900719 ).
instructed_by( nf, hiltonc, 900720 ).
instructed_by( on, hiltonc, 900723 ).
instructed_by( weps, hiltonc, 900731 ).
instructed_by( tacf, hiltonc, 900731 ).
instructed_by( acm, hiltonc, 900731 ).
instructed_by( cq, hiltonc, 900731 ).
instructed_by( bi, fletcherj, 900809 ).
instructed_by( ri, fletcherj, 900207 ).
instructed_by( fam, fletcherj, 910206 ).
instructed_by( form, fletcherj, 910201 ).
instructed_by( nf, fletcherj, 910216 ).
instructed_by( cq, fletcherj, 910228 ).
instructed_by( ccf, patrickm, 910615 ).
instructed_by( on, patrickm, 910524 ).
instructed_by( weps, patrickm, 910512 ).
instructed_by( acm, bussmannl, 910530 ).
instructed_by( cq, bussmannl, 900624 ).
instructed_by( on, myerss, 901015 ).
instructed_by( weps, myerss, 901023 ).
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instructed_by( ri, nordeen, 900703 ).
instructed_by( fam, nordeen, 900630 ).
instructed_by( form, nordeen, 900628 ).
instructed_by( nf, nordeen, 900625 ).
instructed_by( tacf, nordeen, 900624 ).
instructed_by( acm, nordeen, 910621 ).
instructed_by( bi, hatteryk, ^10504 ).
instructed_by( fam, hatteryk, 910512 ).
instructed_by( form, hatteryk, 910514 ).
instructed_by( nf, hatteryk, 910522 ).
instructed_by( fam, reevesb, 900901 ).
instructed_by( form, reevesb, 900906 ).
instructed_by( nf, reevesb, 900915 ).
instructed_by( fam, haffent, 910413 ).
instructed_by( form, haffent, 910406 ).
instructed_by( nf, haffent, 910402 ).
instructed_by( cq, haffent, 910415 ).
instructed_by( an, rolloww, 900930 ).
instructed_by( fam, rolloww, 900925 ).
instructed_by( form, rolloww, 900921 ).
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instructed_by( tacf, rolloww, 900916 ).
instructed_by( acm, rolloww, 900912 ).
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instructed_by( bi, shattuckf, 910520 ).
instructed_by( form, shattuckf, 910522 ).
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instructed_by( form, maurerw, 900714 ).
instructed_by( nf, maurerw, 900722 ).
instructed_by( fam, boronkay, 900909 ).
instructed_by( form, boronkay, 900907 ).
instructed_by( nf, boronkay, 900923 ).
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instructed_by( form, johnsons, 900902 ).
instructed_by( nf, johnsons, 900919 ).
instructed_by( bi, mesmerk, 900916 ).
instructed_by( fam, mesmerk, 901001 ).
instructed_by( form, mesmerk, 901023 ).
instructed_by( nf, mesmerk, 901023 ).
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instructed_by( form, ferrisop, 901228 ).
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instructed_by( an, crossv, 901203 ).
instructed_by( fam, crossv, 901207 ).
instructed_by( form, crossv, 901217 ).
instructed_by( nf, crossv, 901223 ).
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instructed_by( on, waltersa, 900704 ).
instructed_by( tacf, waltersa, 900716 ).
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instructed_by( tacf, brurude, 910517 ).
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instructed_by( nf, gallaghers, 910103 ).
instructed_by( on, gallaghers, 910105 ).
instructed_by( weps, gallaghers, 910109 ).
instructed_by( form, pitzerg, 910207 ).
instructed_by( an, pitzerg, 910212 ).
instructed_by( nf, pitzerg, 910214 ).
instructed_by( on, pitzerg, 910216 ).
instructed_by( weps, pitzerg, 910221 ).
instructed_by( fam, riggsb, 910330 ).
instructed_by( form, riggsb, 910331 ).
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```prolog
instructed_by( nf, riggsb, 910328 ).
instructed_by( ocf, paparoj, 900812 ).
instructed_by( fam, paparoj, 900818 ).
instructed_by( form, paparoj, 900817 ).
instructed_by( nf, paparoj, 900815 ).


doable( cq14x, STUD_NAME, TIME ):-
        completed( STUD_NAME, DATE1, cq13x, X1, FLT_TIME1 ),
        completed( STUD_NAME, DATE2, ep9s, X2, FLT_TIME2 ).
doable( cq12, STUD_NAME, TIME ):- sunset(SUNSET), TIME < (SUNSET - 100),
        completed( STUD_NAME, DATE, cq11, X, FLT_TIME ).
doable( cq4, STUD_NAME, TIME ) :- sunset(SUNSET), TIME < (SUNSET - 100),
        completed( STUD_NAME, DATE, cq3, X, FLT_TIME ).
doable( cq3, STUD_NAME, TIME ) :- sunset(SUNSET), TIME < (SUNSET - 100),
        completed( STUD_NAME, DATE, cq2, X, FLT_TIME ).
doable( cq2, STUD_NAME, TIME ) :- sunset(SUNSET), TIME < (SUNSET - 100),
        completed( STUD_NAME, DATE, cq1, X, FLT_TIME ).
doable( cq1, STUD_NAME, TIME ) :- sunset(SUNSET), TIME < (SUNSET - 100),
        student( STUD_NAME, SIM_HRS, NT_HRS, AC_HRS,DATE_LAST_FLEW ),
        AC_HRS > 65,
        completed( STUD_NAME, DATE1, an14s, X1, FLT_TIME1 ),
        completed( STUD_NAME, DATE2, nf5, X2, FLT_TIME2 ),
        completed( STUD_NAME, DATE3, fam10, X3, FLT_TIME3 ).
doable( acm4, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE1, acm3x, X1, FLT_TIME1 ),
        completed( STUD_NAME, DATE2, ocf3, X2, FLT_TIME2 ).
doable( acm2, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE1, acm1, X1, FLT_TIME1 ),
        completed( STUD_NAME, DATE2, tacf4, X2, FLT_TIME2 ).
doable( acm1, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE, ocf3, X, FLT_TIME ),
        student( STUD_NAME, SIM_HRS, NT_HRS, AC_HRS, DATE_LAST_FLEW ),
        ((SIM_HRS < 15, (SIM_HRS + AC_HRS) >= 45); AC_HRS >= 30).
doable( ocf3, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE, form5, X, FLT_TIME ).
doable( wep1, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE, form5, X, FLT_TIME ).
doable( tacf4, STUD_NAME, TIME) :-
        completed( STUD_NAME, DATE1, tacf3x, X1, FLT_TIME1 ),
        completed( STUD_NAME, DATE2, on5x, X2, FLT_TIME2 ).
doable( tacf2, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE1, tacf1, X1, FLT_TIME1 ),
        completed( STUD_NAME, DATE2, ep8s, X2, FLT_TIME2 ).
doable( tacf1, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE, form5, X, FLT_TIME ).
doable( on6x, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE1, on5x, X1, FLT_TIME1 ),
        completed( STUD_NAME, DATE2, wep4x, X2, FLT_TIME2 ),
        completed( STUD_NAME, DATE3, tacf4, X3, FLT_TIME3 ).
doable( on1, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE, form3, X, FLT_TIME ).
doable( nf5, STUD_NAME, TIME ) :- get_night(NIGHT), TIME >= NIGHT,
        completed( STUD_NAME, DATE, nf4, X, FLT_TIME ).
doable( nf4, STUD_NAME, TIME ) :- get_night(NIGHT), TIME >= NIGHT,
        completed( STUD_NAME, DATE, nf3x, X, FLT_TIME ).
doable( nf3x, STUD_NAME, TIME ) :- get_night(NIGHT), TIME >= NIGHT,
        completed( STUD_NAME, DATE, nf2, X, FLT_TIME ).
doable( nf2, STUD_NAME, TIME ) :- get_night(NIGHT), TIME >= NIGHT,
        completed( STUD_NAME, DATE, nf1, X, FLT_TIME ).
doable( nf1, STUD_NAME, TIME ) :- get_night(NIGHT), TIME >= NIGHT,
        completed( STUD_NAME, DATE, form3, X, FLT_TIME ).
doable( form3, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE1, form2x, X1, FLT_TIME1 ),
        completed( STUD_NAME, DATE2, fam8, X2, FLT_TIME2 ).
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doable( form1, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE, fam7x, X, FLT_TIME ).
doable( ep8s, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE, fam8, X, FLT_TIME ).
doable( fam9, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE1, fam8, X1, FLT_TIME1 ),
        completed( STUD_NAME, DATE2, form5, X2, FLT_TIME2 ).
doable( fam7x, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE1, fam6, X1, FLT_TIME1 ),
        completed( STUD_NAME, DATE2, co8s, X2, FLT_TIME2 ).
doable( fam6, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE1, fam5, X1, FLT_TIME1 ),
        completed( STUD_NAME, DATE2, co7s, X2, FLT_TIME2 ).
doable( fam1, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE, an10x, X, FLT_TIME ).
doable( co8s, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE, fam4, X, FLT_TIME ).
doable( co7s, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE, an5xs, X, FLT_TIME ).
doable( an17, STUD_NAME, TIME ) :-
        completed(STUD_NAME, DATE1, an14s, X1, FLT_TIME1 ),
        not (completed( STUD_NAME, DATE2, an15s, X2, FLT_TIME2 ) ).
doable( an16, STUD_NAME, TIME ) :- get_night(NIGHT), TIME >= NIGHT,
        completed( STUD_NAME, DATE, an15s, X, FLT_TIME ).
doable( an15s, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE1, an14s, X1, FLT_TIME1 ),
        not( completed( STUD_NAME, DATE2, an17, X2, FLT_TIME2 ) ).
doable( an15s, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE1, an17, X1, FLT_TIME1 ),
        completed( STUD_NAME, DATE2, an18, X2, FLT_TIME2 ).
doable( an14s, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE1, an13, X1, FLT_TIME1 ),
        completed( STUD_NAME, DATE2, wep11, X2, FLT_TIME2 ).
doable( an14s, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE1, an13, X1, FLT_TIME1 ),
        completed( STUD_NAME, DATE2, acm13, X2, FLT_TIME2 ).
doable( an13, STUD_NAME, TIME) :-
        completed( STUD_NAME, DATE1, an11s, X1, FLT_TIME1 ),
        completed( STUD_NAME, DATE2, form5, X2, FLT_TIME2),
        completed( STUD_NAME, DATE3, nf2, X3, FLT_TIME3 ),
        sked(EVT, SQDN, STUD_NAME, INSTR_NAME, an12, TIME1, ETE, RMKS),
        get_night(NIGHT), (TIME >= NIGHT; TIME1 >= NIGHT).
doable( an12, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE1, an11, X1, FLT_TIME1 ),
        completed( STUD_NAME, DATE2, form5, X2, FLT_TIME2 ),
        completed( STUD_NAME, DATE3, nf2, X3, FLT_TIME3 ),
        sked(EVT, SQDN, STUD_NAME, INSTR_NAME, an13, TIME1, ETE, RMKS),
        get_night(NIGHT), (TIME >= NIGHT; TIME1 >= NIGHT).
doable( an11s, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE1, an10x, X1, FLT_TIME1 ),
        completed( STUD_NAME, DATE2, form5, X2, FLT_TIME2 ).
doable( an10x, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE, an9, X, FLT_TIME ),
        student( STUD_NAME, SIM_HRS, NT_HRS, AC_HRS, LAST_DATE_FLEW ),
        NT_HRS >= 3.8.
doable( an3s, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE1, an2s, X1, FLT_TIME1 ),
        completed( STUD_NAME, DATE2, ri15x, X2, FLT_TIME2 ).
doable( ri3s, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE1, ri2s, X1, FLT_TIME1 ),
        completed( STUD_NAME, DATE2, bi10x, X2, FLT_TIME2 ).
doable( bi8xs, STUD_NAME, TIME ) :-
        completed( STUD_NAME, DATE1, co5s, X1, FLT_TIME1 ),
        completed( STUD_NAME, DATE2, bi7s, X2, FLT_TIME2).
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doable( co3s, STUD_NAME ).

get_night(NIGHT):- sunset(SUNSET), T1 is (SUNSET mod 100),
        find_time(NIGHT,SUNSET, T1).

find_time(NIGHT, SUNSET, T1):- T1 > 29, T1 < 60, T2 is (T1 - 30),
        T3 is (SUNSET - T1), NIGHT is (T3 + 100 + T2).
find_time(NIGHT, T1, T2):- T1 < 30, NIGHT is (SUNSET + 30).

prereq(cq13x, cq12).
prereq( cq11, cq10 ).
prereq( cq10, cq9 ).
prereq( cq9, cq8 ).
prereq( cq8, cq7 ).
prereq( cq7, cq6 ).
prereq( cq6, cq5 ).
prereq( cq5, cq4 ).
prereq( acm13, acm12 ).
prereq( acm12, acm11x ).
prereq( acm11x, acm10 ).
prereq( acm10, acm9 ).
prereq( acm9, acm8 ).
prereq( acm8, acm7 ).
prereq( acm7, acm6x ).
prereq( acm6x, acm5 ).
prereq( acm5, acm4 ).
prereq( acm3x, acm2 ).
prereq( wep11, wep10 ).
prereq( wep10, wep9 ).
prereq( wep9, wep8 ).
prereq( wep8, wep7 ).
prereq( wep7, wep6 ).
prereq( wep6, wep5 ).
prereq( wep5, wep4x ).
prereq( wep4x, wep3 ).
prereq( wep3, wep2 ).
prereq( wep2, wep1 ).
prereq( tacf3x, tacf2 ).
prereq( on7, on6x ).
prereq( on5x, on4 ).
prereq( on4, on3 ).
prereq( on3, on2 ).
prereq( on2, on1 ).
prereq( form5, form4x ).
prereq( form4x, form3 ).
prereq( form2x, form1 ).
prereq( fam10, fam9 ).
prereq( fam8, fam7x ).
prereq( fam5, fam4 ).
prereq( fam4, fam3 ).
prereq( fam3, fam2 ).
prereq( fam2, fam1 ).
prereq( an18, an17 ).
prereq( an9, an8 ).
prereq( an8, an7 ).
prereq( an7, an6 ).
prereq( an6, an5xs ).
prereq( an5xs, an4s ).
prereq( an4s, an3s ).
prereq( an2s, an1s ).
prereq( an1s, ri15x ).
prereq( ri15x, ri14 ).
prereq( ri14, ri13 ).
prereq( ri13, ri12 ).
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prereq( ri12, ri11xs ).
prereq( ri11xs, ri10s ).
prereq( ri10s, ri9s ).
prereq( ri9s, ri8s ).
prereq( ri8s, ri7s ).
prereq( ri7s, ri6s ).
prereq( ri6s, ri5s ).
prereq( ri5s, ri4s ).
prereq( ri4s, ri3s ).
prereq( ri2s, ri1s ).
prereq( ri1s, bi1s ).
prereq( bi10x, bi9 ).
prereq( bi9, bi8xs ).
prereq( bi7s, bi6s ).
prereq( bi6s, bi5s ).
prereq( bi5s, bi4s ).
prereq( bi4s, bi3s ).
prereq( bi3s, bi2s ).
prereq( bi2s, bi1s ).
prereq( bi1s, co3s ).
prereq( co5s, co4s ).
prereq( co4s, co3s ).

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segment( ep, ep9s, s ).
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segment( bi, bi5s, s ).
segment( bi, bi6s, s ).
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segment( bi, bi10x, p ).
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segment( ri, ri6s, s ).
segment( ri, ri7s, s ).
segment( ri, ri8s, s ).
segment( ri, ri9s, s ).
segment( ri, ri10s, s ).
segment( ri, ri11xs, s ).
segment( ri, ri12, p ).
segment( ri, ri13, p ).
segment( ri, ri14, p ).
segment( ri, ri15x, p ).
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segment( an, an3s, s ).
segment( an, an4s, s ).
segment( an, an5xs, s ).
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segment( an, an7, p ).
segment( an, an8, p ).
segment( an, an9, p ).
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segment( an,   an10x, p ).
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segment( an,   an15s, s ).
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segment( an,   an18,  p ).
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segment( fam,  fam3,  p ).
segment( fam,  fam4,  p ).
segment( fam,  fam5,  p ).
segment( fam,  fam6,  p ).
segment( fam,  fam7x, p ).
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segment( fam,  fam9,  p ).
segment( fam,  fam10, p ).
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segment( form, form2x, p ).
segment( form, form3, p ).
segment( form, form4x, p ).
segment( form, form5, p ).
segment( nf,   nf1,   p ).
segment( nf,   nf2,   p ).
segment( nf,   nf3x,  p ).
segment( nf,   nf4,   p ).
segment( nf,   nf5,   p ).
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segment( on,   on2,   p ).
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segment( on,   on6x,  p ).
segment( on,   on7,   p ).
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segment( tacf, tacf3x, p ).
segment( tacf, tacf4, p ).
segment( wep,  wep1,  p ).
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segment( wep,  wep3,  p ).
segment( wep,  wep4x, p ).
segment( wep,  wep5,  p ).
segment( wep,  wep6,  p ).
segment( wep,  wep7x, p ).
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segment( wep,  wep9,  p ).
segment( wep,  wep10, p ).
segment( wep,  wep11, p ).
segment( ocf,  ocf3,  p ).
segment( acm,  acm1,  p ).
segment( acm,  acm2,  p ).
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segment( acm,  acm5,  p ).
segment( acm,  acm6x, p ).
segment( acm,  acm7,  p ).
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segment( acm,  acm10, p ).
segment( acm,  acm11x, p ).
segment( acm,  acm12, p ).
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segment( cq, cq10, p ).
segment( cq, cq11, p ).
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segment( cq, cq13x, p ).
segment( cq, cq14x, p ).


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flight_duration( ri7s, 2.0 ).
flight_duration( ri8s, 2.0 ).
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flight_duration( an8, 1.6 ).
flight_duration( an9, 1.6 ).
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flight_duration( an13, 1.5 ).
flight_duration( an14s, 2.0 ).
flight_duration( an15s, 2.0 ).
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flight_duration( an16, 1.6 ).
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flight_duration( fam5, 1.4 ).
flight_duration( fam6, 1.4 ).
flight_duration( fam7x, 1.4 ).
flight_duration( fam8, 1.4 ).
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completed( sethj, 890528, bi3s, s, a ).
completed( sethj, 890520, bi2s, s, a ).
completed( sethj, 890518, co3s, s, a ).
completed( sethj, 890517, bi1s, s, a ).
completed( cruzb, 900616, acm12, d, aa ).
completed( cruzb, 900615, acm11x, d, a ).
completed( cruzb, 900607, fam10, d, a ).
completed( cruzb, 891222, acm10, d, a ).
completed( cruzb, 891222, acm9, d, aa ).
completed( cruzb, 891222, acm8, d, a ).
completed( cruzb, 891222, acm7, d, a ).
completed( cruzb, 891222, acm6x, d, aa ).
completed( cruzb, 891222, acm5, d, a ).
completed( cruzb, 891222, acm4, d, a ).
completed( cruzb, 891222, acm3x, d, a ).
completed( cruzb, 891222, acm2, d, aa ).
completed( cruzb, 891222, acm1, d, aa ).
completed( cruzb, 891222, ocf3, d, aa ).
```

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```
completed( cruzb, 891222, an18, d, a ).
completed( cruzb, 891222, an17, n, aa ).
completed( cruzb, 891222, an16, n, a ).
completed( cruzb, 891222, an15s, s, a ).
completed( cruzb, 891222, an14s, s, a ).
completed( cruzb, 891222, wep11, d, a ).
completed( cruzb, 891222, wep10, d, aa ).
completed( cruzb, 891222, wep9, d. a ).
completed( cruzb, 891222, wep8, d, a ).
completed( cruzb, 891222, wep7x, d, a ).
completed( cruzb, 891222, wep6, d, a ).
completed( cruzb, 891222, wep5, d, a ).
completed( cruzb, 891222, on7, d, aa ).
completed( cruzb, 891222, on6x, d, aa ).
completed( cruzb, 891222, wep4x, d, aa ).
completed( cruzb, 891222, wep3, d, a ).
completed( cruzb, 891222, wep2, d, a ).
completed( cruzb, 891222, wep1, d, a ).
completed( cruzb, 891222, tacf4, d, a ).
completed( cruzb, 891222, tacf3x, d, a ).
completed( cruzb, 891222, tacf2, d, a ).
completed( cruzb, 891222, tacf1, d, aa ).
completed( cruzb, 891222, on5x, d, a ).
completed( cruzb, 891222, on4, d, aa ).
completed( cruzb, 891222, on3, d, aa ).
completed( cruzb, 891222, on2, d, a ).
completed( cruzb, 891222, on1, d, a ).
completed( cruzb, 891222, nf5, n, a ).
completed( cruzb, 891222, nf4, n, a ).
completed( cruzb, 891222, nf3x, n, a ).
completed( cruzb, 891222, fam9, d, a ).
completed( cruzb, 891114, an13, n, aa ).
completed( cruzb, 891111, an12, d, aa ).
completed( cruzb, 891110, an11s, s, a ).
completed( cruzb, 891109, nf2, n, a ).
completed( cruzb, 891108, form5, d, a ).
completed( cruzb, 891108, nf1, n, a ).
completed( cruzb, 891108, form4x, d, a ).
completed( cruzb, 891108, form3, d, a ).
completed( cruzb, 891107, form2x, d, a ).
completed( cruzb, 891105, ep8s, s, a ).
completed( cruzb, 891030, fam8, d, a ).
completed( cruzb, 891025, form1, d, a ).
completed( cruzb, 891019, fam7x, d, aa ).
completed( cruzb, 891015, fam6, d, aa ).
completed( cruzb, 891012, fam5, d, aa ).
completed( cruzb, 890927, co8s, s, a ).
completed( cruzb, 890924, fam4, d, aa ).
completed( cruzb, 890923, fam3, d, a ).
completed( cruzb, 890920, fam2, d, aa ).
completed( cruzb, 890920, fam1, d, aa ).
completed( cruzb, 890915, an10x, d, a ).
completed( cruzb, 890912, an9, d, a ).
completed( cruzb, 890911, an8, d, a ).
completed( cruzb, 890905, an7, d, a ).
completed( cruzb, 890901, co7s, s, a ).
completed( cruzb, 890830, an6, d, aa ).
completed( cruzb, 890822, an5xs, s, a ).
completed( cruzb, 890821, an4s, s, a ).
completed( cruzb, 890817, an3s, s, a ).
completed( cruzb, 890812, an2s, s, a ).
completed( cruzb, 890805, an1s, s, a ).
completed( cruzb, 890804, ri15x, d, aa ).
completed( cruzb, 890801, ri14, d, a ).
```

```
completed( cruzb, 890727, ri13, d, aa ).
completed( cruzb, 890725, ri12, d, a ).
completed( cruzb, 890724, ri11xs, s, a ).
completed( cruzb, 890723, ri10s, s, a ).
completed( cruzb, 890721, ri9s, s, a ).
completed( cruzb, 890719, ri8s, s, a ).
completed( cruzb, 890716, ri7s, s, a ).
completed( cruzb, 890714, ri6s, s, a ).
completed( cruzb, 890712, ri5s, s, a ).
completed( cruzb, 890703, ri4s, s, a ).
completed( cruzb, 890701, ri3s, s, a ).
completed( cruzb, 890621, ri2s, s, a ).
completed( cruzb, 890621, ri1s, s, a ).
completed( cruzb, 890618, bi10x, d, aa ).
completed( cruzb, 890617, bi9, d, aa ).
completed( cruzb, 890615, bi8xs, s, a ).
completed( cruzb, 890614, co5s, s, a ).
completed( cruzb, 890613, bi7s, s, a ).
completed( cruzb, 890610, co4s, s, a ).
completed( cruzb, 890605, bi6s, s, a ).
completed( cruzb, 890602, bi5s, s, a ).
completed( cruzb, 890601, bi4s, s, a ).
completed( cruzb, 890528, bi3s, s, a ).
completed( cruzb, 890520, bi2s, s, a ).
completed( cruzb, 890518, co3s, s, a ).
completed( cruzb, 890517, bi1s, s, a ).
```

APPENDIX D

TEST RUNS

Here we present three test runs to demonstrate the three different options available in changing a student or instructor. The first run is a case of simple substitution, replacing one instructor with another qualified instructor. The second run is the result of changing scheduled flights. And, the third test run shows the results of completely rescheduling the time period.

```
/******************************************************************/
/*                     THE ORIGINAL SCHEDULE                    */
/*                                                              */
/*    All changes shown in this appendix were made to this schedule    */
/******************************************************************/
```

FLIGHT SCHEDULE
900624

EVT	SQDN	T/O	INSTRUCTOR	STUDENT	FLIGHT	ETE	SIDE #	D/S	TY	HRS	I/C	REMARK
1	22	700	sim	mendiolam	ri3s	2						2F90
1	22	700	sim	thienep	bi4s	2						2F90
2	22	735	zarchya	oehlert	ri15x	1.5						*
2	22	735	sim	chankleg	ri11xs	2						2F90
3	22	810	rolloww	millerc	an7	1.6						*
3	22	810	crossmana	zogers	fam2	1.4						*
4	22	845	hiltonc	clinek	fam3	1.4						*
4	22	845	fletcherj	harrowb	fam8	1.4						*
5	22	920	nordeen	vanekc	form2x	1.4						w/21
5	22	920	waltersa	huffw	tacf1	1.4						*
6	22	955	paparoj	lambb	ocf3	0.8						*
6	22	955	bussmannl	xet	acm6x	1.1						*
7	22	1030	patrickm	bradleyw	ocf3	1.1						*
7	22	1030	merilosl	jonesh	acm13	1.2						*
8	22	1105	hulsed	garciae	acm11x	1.2						*
8	22	1105	seymourw	taffp	acm13	1.2						*
9	22	1140	fletcherj	glasurep	bi9	1.4						*
9	22	1140	sim	leckiew	co7s	2						2F90
10	22	1215	mesmerk	tigarb	fam6	1.4						*
10	22	1215	crossv	leetchk	fam2	1.4						*
11	22	1250	gallaghers	aasena	form4x	1.4						w/21
11	22	1250	pitzerg	burrt	on5x	1.4						*
12	22	1325	myerss	healdh	on4	1.5						*
12	22	1325	sessip	cruzb	acm13	1.2						*
13	22	1400	sim	farquharsonp	bi7s	2						2F90
13	22	1400	hatteryk	mcclured	bi10x	1.4						*
14	22	1435	hiltonc	spagnoloe	ri15x	1.5						*
14	22	1435	sim	simona	co7s	2						2F90
15	22	1510	crossmana	gangia	fam5	1.4						*
15	22	1510	johnsons	tigarc	form3	1.4						w/21
16	22	1545	waltersa	finleyy	tacf2	1.4						*
16	22	1545	rolloww	bello	acm1	1.1						*
17	22	1620	nordeen	bakerk	acm5	1.1						*
17	22	1620	sim	atkinsonm	bi6s	2						2F90
26	22	2135	maurerw	curryy	nf2	0.8						*
26	22	2135	boronkay	beavenr	nf1	1.4						*
27	22	2210	johnsons	aasena	nf1	1.4						*
27	22	2210	bruruda	bakerk	acm5	1.1						*

```
/*****************************************************************/
/*                    INSTRUCTOR REPLACEMENT                    */
/*                                                              */
/*      Resulting in a substitution for the cancelled instructor */
/*****************************************************************/


ai3% prolog
C-Prolog version 1.5
| ?- [reschedule].

        Loading data . . .

database consulted 167648 bytes 28.4667 sec.
update_database consulted 6628 bytes 0.766678 sec.
snivel_log consulted 576 bytes 0.116667 sec.
update_snivel_log consulted 5868 bytes 0.716673 sec.
change_personnel consulted 9944 bytes 1.21667 sec.
completions consulted 2604 bytes 0.316692 sec.
print consulted 3160 bytes 0.366684 sec.

        Remove instructor segment qualifications expiring as of what date?   900624.

        The ri qualification for burgan has been removed.
        The ri qualification for fletcherj has been removed.
        The cq qualification for bussmannl has been removed.
        The tacf qualification for nordeen has been removed.
            END INSTRUCTOR QUALIFICATION UPDATE.


                FLIGHT SCHEDULE

                    1   Database
                    2   Changes
                    3   Snivels
                    4   Print
                    5   Completions
                    6   Change files
                    7   Quit

                Enter choice, 1 to 7:   2.
What file do you want to work with?   skedfacts.

Loading schedule file . . .

skedfacts consulted 2376 bytes 0.433346 sec.
            skedfacts is now open.


                CHANGE PERSONNEL

                    1   Change Instructor
                    2   Change Student
                    3   Quit

                Enter choice, 1 to 3:   1.
```

Enter instructor name: crossmana.

Enter log-out time: 0600.

Enter log-in time: 1300.

crossmana has been entered in the Snivel Log for the period
900624 from 600 to 1300.

Searching . . .

        All flights for crossmana have been adjusted.

        FLIGHT SCHEDULE

            1   Database
            2   Changes
            3   Snivels
            4   Print
            5   Completions
            6   Change files
            7   Quit

        Enter choice, 1 to 7:   4.

FLIGHT SCHEDULE
900624

EVT	:SQDN	:T/O	:INSTRUCTOR	:STUDENT	:FLIGHT	:ETE	:SIDE #	:D/S	:TY	:HRS	:I/C	:REMARK
1 :	22 :	700:	sim	:mendiolam	:ri3s	:2	:	:	:	:	:	:2F90
1 :	22 :	700:	sim	:thienep	:bi4s	:2	:	:	:	:	:	:2F90
2 :	22 :	735:	zarchya	:oehlert	:ri15x	:1.5	:	:	:	:	:	:*
2 :	22 :	735:	sim	:chankleg	:ri11xs	:2	:	:	:	:	:	:2F90
3 :	22 :	810:	zupicj	:zogers	:fam2	:1.4	:	:	:	:	:	:*
3 :	22 :	810:	rolloww	:millerc	:an7	:1.6	:	:	:	:	:	:*
4 :	22 :	845:	hiltonc	:clinek	:fam3	:1.4	:	:	:	:	:	:*
4 :	22 :	845:	fletcherj	:harrowb	:fam8	:1.4	:	:	:	:	:	:*
5 :	22 :	920:	nordeen	:vanekc	:form2x	:1.4	:	:	:	:	:	:w/21
5 :	22 :	920:	waltersa	:huffw	:tacf1	:1.4	:	:	:	:	:	:*
6 :	22 :	955:	paparoj	:lambb	:ocf3	:0.8	:	:	:	:	:	:*
6 :	22 :	955:	bussmannl	:xet	:acm6x	:1.1	:	:	:	:	:	:*
7 :	22 :	1030:	patrickm	:bradleyw	:ocf3	:1.1	:	:	:	:	:	:*
7 :	22 :	1030:	merilosl	:jonesh	:acm13	:1.2	:	:	:	:	:	:*
8 :	22 :	1105:	hulsed	:garciae	:acm11x	:1.2	:	:	:	:	:	:*
8 :	22 :	1105:	seymourw	:taffp	:acm13	:1.2	:	:	:	:	:	:*
9 :	22 :	1140:	fletcherj	:glasurep	:bi9	:1.4	:	:	:	:	:	:*
9 :	22 :	1140:	sim	:leckiew	:co7s	:2	:	:	:	:	:	:2F90
10 :	22 :	1215:	mesmerk	:tigarb	:fam6	:1.4	:	:	:	:	:	:*
10 :	22 :	1215:	crossv	:leetchk	:fam2	:1.4	:	:	:	:	:	:*
11 :	22 :	1250:	gallaghers	:aasena	:form4x	:1.4	:	:	:	:	:	:w/21
11 :	22 :	1250:	pitzerg	:burrt	:on5x	:1.4	:	:	:	:	:	:*
12 :	22 :	1325:	myerss	:healdh	:on4	:1.5	:	:	:	:	:	:*
12 :	22 :	1325:	sessip	:cruzb	:acm13	:1.2	:	:	:	:	:	:*
13 :	22 :	1400:	sim	:farquharsonp	:bi7s	:2	:	:	:	:	:	:2F90
13 :	22 :	1400:	hatteryk	:mcclured	:bi10x	:1.4	:	:	:	:	:	:*
14 :	22 :	1435:	hiltonc	:spagnoloe	:ri15x	:1.5	:	:	:	:	:	:*
14 :	22 :	1435:	sim	:simona	:co7s	:2	:	:	:	:	:	:2F90
15 :	22 :	1510:	crossmana	:gangia	:fam5	:1.4	:	:	:	:	:	:*
15 :	22 :	1510:	johnsons	:tigarc	:form3	:1.4	:	:	:	:	:	:w/21
16 :	22 :	1545:	waltersa	:finleyy	:tacf2	:1.4	:	:	:	:	:	:*
16 :	22 :	1545:	rolloww	:bello	:acm1	:1.1	:	:	:	:	:	:*
17 :	22 :	1620:	nordeen	:bakerk	:acm5	:1.1	:	:	:	:	:	:*
17 :	22 :	1620:	sim	:atkinsonm	:bi6s	:2	:	:	:	:	:	:2F90
26 :	22 :	2135:	maurerw	:curryy	:nf2	:0.8	:	:	:	:	:	:*
26 :	22 :	2135:	boronkay	:beavenr	:nf1	:1.4	:	:	:	:	:	:*
27 :	22 :	2210:	johnsons	:aasena	:nf1	:1.4	:	:	:	:	:	:*
27 :	22 :	2210:	bruruda	:bakerk	:acm5	:1.1	:	:	:	:	:	:*

Press any key to continue.m.

```
FLIGHT SCHEDULE

        1  Database
        2  Changes
        3  Snivels
        4  Print
        5  Completions
        6  Change files
        7  Quit

        Enter choice, 1 to 7:   7.
Do you want to quit?  y.


    Closing data files . . .
```

```
/******************************************************************/
/*                  INSTRUCTOR REPLACEMENT                      */
/*                                                              */
/*      Resulting in a new flight and instructor for the remaining student    */
/******************************************************************/


ai3% prolog
C-Prolog version 1.5
| ?- [reschedule].

        Loading data . . .

database consulted 167648 bytes 28.8167 sec.
update_database consulted 6628 bytes 0.816671 sec.
snivel_log consulted 576 bytes 0.100006 sec.
update_snivel_log consulted 5868 bytes 0.700005 sec.
change_personnel consulted 9944 bytes 1.20001 sec.
completions consulted 2604 bytes 0.316685 sec.
print consulted 3160 bytes 0.383339 sec.

        Remove instructor segment qualifications expiring as of what date?   900624.

        The ri qualification for burgan has been removed.
        The ri qualification for fletcherj has been removed.
        The cq qualification for bussmannl has been removed.
        The tacf qualification for nordeen has been removed.
                END INSTRUCTOR QUALIFICATION UPDATE.


                FLIGHT SCHEDULE

                1  Database
                2  Changes
                3  Snivels
                4  Print
                5  Completions
                6  Change files
                7  Quit


        Enter choice, 1 to 7:   2.
What file do you want to work with?   skedfacts.

Loading schedule file . . .

skedfacts consulted 2376 bytes 0.450016 sec.
            skedfacts is now open.



                CHANGE PERSONNEL

                1  Change Instructor
                2  Change Student
                3  Quit

        Enter choice, 1 to 3:   1.
```

Enter instructor name: pitzerg.

Enter log-out time: 0001.

Enter log-in time: 2400.

pitzerg has been entered in the Snivel Log for the period
900624 from 1 to 2400.

Searching . . .

        All flights for pitzerg have been adjusted.

        FLIGHT SCHEDULE

            1   Database
            2   Changes
            3   Snivels
            4   Print
            5   Completions
            6   Change files
            7   Quit

        Enter choice, 1 to 7: 4.

EVT	:SQDN	:T/O	:INSTRUCTOR	:STUDENT	:FLIGHT	:ETE	:SIDE #	:D/S	:TY	:HRS	:I/C	:REMARK
1 :	22 :	700	:sim	:mendiolam	:ri3s	:2	:____	:___	:___	:___	:___	:2F90
1 :	22 :	700	:sim	:thienep	:bi4s	:2	:____	:___	:___	:___	:___	:2F90
2 :	22 :	735	:zarchya	:oehlert	:ri15x	:1.5	:____	:___	:___	:___	:___	:*
2 :	22 :	735	:sim	:chankleg	:ri11xs	:2	:____	:___	:___	:___	:___	:2F90
3 :	22 :	810	:rolloww	:millerc	:an7	:1.6	:____	:___	:___	:___	:___	:*
3 :	22 :	810	:crossmana	:zogers	:fam2	:1.4	:____	:___	:___	:___	:___	:*
4 :	22 :	845	:hiltonc	:clinek	:fam3	:1.4	:____	:___	:___	:___	:___	:*
4 :	22 :	845	:fletcherj	:harrowb	:fam8	:1.4	:____	:___	:___	:___	:___	:*
5 :	22 :	920	:nordeen	:vanekc	:form2x	:1.4	:____	:___	:___	:___	:___	:w/21
5 :	22 :	920	:waltersa	:huffw	:tacf1	:1.4	:____	:___	:___	:___	:___	:*
6 :	22 :	955	:paparoj	:lambb	:ocf3	:0.8	:____	:___	:___	:___	:___	:*
6 :	22 :	955	:bussmannl	:xet	:acm6x	:1.1	:____	:___	:___	:___	:___	:*
7 :	22 :	1030	:patrickm	:bradleyw	:ocf3	:1.1	:____	:___	:___	:___	:___	:*
7 :	22 :	1030	:merilosl	:jonesh	:acm13	:1.2	:____	:___	:___	:___	:___	:*
8 :	22 :	1105	:hulsed	:garciae	:acm11x	:1.2	:____	:___	:___	:___	:___	:*
8 :	22 :	1105	:seymourw	:taffp	:acm13	:1.2	:____	:___	:___	:___	:___	:*
9 :	22 :	1140	:fletcherj	:glasurep	:bi9	:1.4	:____	:___	:___	:___	:___	:*
9 :	22 :	1140	:sim	:leckiew	:co7s	:2	:____	:___	:___	:___	:___	:2F90
10 :	22 :	1215	:mesmerk	:tigarb	:fam6	:1.4	:____	:___	:___	:___	:___	:*
10 :	22 :	1215	:crossv	:leetchk	:fam2	:1.4	:____	:___	:___	:___	:___	:*
11 :	22 :	1250	:brurude	:burrt	:tacf1	:1.4	:____	:___	:___	:___	:___	:*
11 :	22 :	1250	:gallaghers	:aasena	:form4x	:1.4	:____	:___	:___	:___	:___	:w/21
12 :	22 :	1325	:myerss	:healdh	:on4	:1.5	:____	:___	:___	:___	:___	:*
12 :	22 :	1325	:sessip	:cruzb	:acm13	:1.2	:____	:___	:___	:___	:___	:*
13 :	22 :	1400	:sim	:farquharsonp	:bi7s	:2	:____	:___	:___	:___	:___	:2F90
13 :	22 :	1400	:hatteryk	:mcclured	:bi10x	:1.4	:____	:___	:___	:___	:___	:*
14 :	22 :	1435	:hiltonc	:spagnoloe	:ri15x	:1.5	:____	:___	:___	:___	:___	:*
14 :	22 :	1435	:sim	:simona	:co7s	:2	:____	:___	:___	:___	:___	:2F90
15 :	22 :	1510	:crossmana	:gangia	:fam5	:1.4	:____	:___	:___	:___	:___	:*
15 :	22 :	1510	:johnsons	:tigarc	:form3	:1.4	:____	:___	:___	:___	:___	:w/21
16 :	22 :	1545	:waltersa	:finleyy	:tacf2	:1.4	:____	:___	:___	:___	:___	:*
16 :	22 :	1545	:rolloww	:bello	:acm1	:1.1	:____	:___	:___	:___	:___	:*
17 :	22 :	1620	:nordeen	:bakerk	:acm5	:1.1	:____	:___	:___	:___	:___	:*
17 :	22 :	1620	:sim	:atkinsonm	:bi6s	:2	:____	:___	:___	:___	:___	:2F90
26 :	22 :	2135	:maurerw	:curryy	:nf2	:0.8	:____	:___	:___	:___	:___	:*
26 :	22 :	2135	:boronkay	:beavenr	:nf1	:1.4	:____	:___	:___	:___	:___	:*
27 :	22 :	2210	:johnsons	:aasena	:nf1	:1.4	:____	:___	:___	:___	:___	:*
27 :	22 :	2210	:bruruda	:bakerk	:acm5	:1.1	:____	:___	:___	:___	:___	:*

Press any key to continue.m.

```
FLIGHT SCHEDULE

        1   Database
        2   Changes
        3   Snivels
        4   Print
        5   Completions
        6   Change files
        7   Quit

        Enter choice, 1 to 7:   7.
Do you want to quit?   y.


    Closing data files . . .
```

```
/*****************************************************************************/
/*                        STUDENT REPLACEMENT                             */
/*                                                                        */
/*      Resulting in a substitution for the cancelled student             */
/*****************************************************************************/


ai3% prolog
C-Prolog version 1.5
| ?- [reschedule].

      Loading data . . .

database consulted 167648 bytes 28.5333 sec.
update_database consulted 6628 bytes 0.816675 sec.
snivel_log consulted 664 bytes 0.116676 sec.
update_snivel_log consulted 5868 bytes 0.700006 sec.
change_personnel consulted 10100 bytes 1.23335 sec.
completions consulted 2604 bytes 0.300011 sec.
print consulted 3160 bytes 0.349998 sec.

      Remove instructor segment qualifications expiring as of what date?   900624.

      The ri qualification for burgan has been removed.
      The ri qualification for fletcherj has been removed.
      The cq qualification for bussmannl has been removed.
      The tacf qualification for nordeen has been removed.
            END INSTRUCTOR QUALIFICATION UPDATE.


            FLIGHT SCHEDULE

                1  Database
                2  Changes
                3  Snivels
                4  Print
                5  Completions
                6  Change files
                7  Quit

            Enter choice, 1 to 7:   2.
What file do you want to work with?   skedfacts.

Loading schedule file . . .

skedfacts consulted 2376 bytes 0.43335 sec.
            skedfacts is now open.


            CHANGE PERSONNEL

                1  Change Instructor
                2  Change Student
                3  Quit

            Enter choice, 1 to 3:   2.
```

Enter student name: cruzb.

Enter log-out time: 1300.

Enter log-in time: 1700.

cruzb has been entered in the Snivel Log for the period
900624 from 1300 to 1700.

Searching . . .
          All flights for cruzb have been adjusted.

          FLIGHT SCHEDULE

              1 Database
              2 Changes
              3 Snivels
              4 Print
              5 Completions
              6 Change files
              7 Quit

          Enter choice, 1 to 7: 4.

FLIGHT SCHEDULE
900624

EVT	SQDN	T/O	INSTRUCTOR	STUDENT	FLIGHT	ETE	SIDE #	D/S	TY	HRS	I/C	REMARKS
1	22	700	sim	mendiolam	ri3s	2						2F90
1	22	700	sim	thienep	bi4s	2						2F90
2	22	735	zarchya	oehlert	ri15x	1.5						*
2	22	735	sim	chankleg	ri11xs	2						2F90
3	22	810	rolloww	millerc	an7	1.6						*
3	22	810	crossmana	zogers	fam2	1.4						*
4	22	845	hiltonc	clinek	fam3	1.4						*
4	22	845	fletcherj	harrowb	fam8	1.4						*
5	22	920	nordeen	vanekc	form2x	1.4						w/21
5	22	920	waltersa	huffw	tacf1	1.4						*
6	22	955	paparoj	lambb	ocf3	0.8						*
6	22	955	bussmannl	xet	acm6x	1.1						*
7	22	1030	patrickm	bradleyw	ocf3	1.1						*
7	22	1030	merilosl	jonesh	acm13	1.2						*
8	22	1105	hulsed	garciae	acm11x	1.2						*
8	22	1105	seymourw	taffp	acm13	1.2						*
9	22	1140	fletcherj	glasurep	bi9	1.4						*
9	22	1140	sim	leckiew	co7s	2						2F90
10	22	1215	mesmerk	tigarb	fam6	1.4						*
10	22	1215	crossv	leetchk	fam2	1.4						*
11	22	1250	gallaghers	aasena	form4x	1.4						w/21
11	22	1250	pitzerg	burrt	on5x	1.4						*
12	22	1325	sessip	sethj	acm13	1.2						*
12	22	1325	myerss	healdh	on4	1.5						*
13	22	1400	sim	farquharsonp	bi7s	2						2F90
13	22	1400	hatteryk	mcclured	bi10x	1.4						*
14	22	1435	hiltonc	spagnoloe	ri15x	1.5						*
14	22	1435	sim	simona	co7s	2						2F90
15	22	1510	crossmana	gangia	fam5	1.4						*
15	22	1510	johnsons	tigarc	form3	1.4						w/21
16	22	1545	waltersa	finleyy	tacf2	1.4						*
16	22	1545	rolloww	bello	acm1	1.1						*
17	22	1620	nordeen	bakerk	acm5	1.1						*
17	22	1620	sim	atkinsonm	bi6s	2						2F90
26	22	2135	maurerw	curryy	nf2	0.8						*
26	22	2135	boronkay	beavenr	nf1	1.4						*
27	22	2210	johnsons	aasena	nf1	1.4						*
27	22	2210	bruruda	bakerk	acm5	1.1						*

Press any key to continue.m.

```
FLIGHT SCHEDULE

        1  Database
        2  Changes
        3  Snivels
        4  Print
        5  Completions
        6  Change files
        7  Quit

        Enter choice, 1 to 7:  7.
Do you want to quit?  y.


    Closing data files . . .
```

```
/***********************************************************************/
/*                        STUDENT REPLACEMENT                          */
/*                                                                     */
/*      Resulting in a new flight and student for the remaining instructor   */
/***********************************************************************/


ai3% prolog
C-Prolog version 1.5
| ?- [reschedule].

     Loading data . . .

database consulted 167648 bytes 28.7 sec.
update_database consulted 6628 bytes 0.716681 sec.
snivel_log consulted 576 bytes 0.100004 sec.
update_snivel_log consulted 5868 bytes 0.683348 sec.
change_personnel consulted 9944 bytes 1.2 sec.
completions consulted 2604 bytes 0.333359 sec.
print consulted 3160 bytes 0.38335 sec.

     Remove instructor segment qualifications expiring as of what date?   900624.

     The ri qualification for ourgan has been removed.
     The ri qualification for fletcherj has been removed.
     The cq qualification for bussmannl has been removed.
     The tacf qualification for nordeen has been removed.
          END INSTRUCTOR QUALIFICATION UPDATE.


               FLIGHT SCHEDULE

               1  Database
               2  Changes
               3  Snivels
               4  Print
               5  Completions
               6  Change files
               7  Quit

          Enter choice, 1 to 7:  2.
What file do you want to work with?  skedfacts.

Loading schedule file . . .

skedfacts consulted 2376 bytes 0.450012 sec.
          skedfacts is now open.


               CHANGE PERSONNEL

               1  Change Instructor
               2  Change Student
               3  Quit

          Enter choice, 1 to 3:  2.
```

```
Enter student name:  tigarc.


Enter log-out time:  1200.


Enter log-in time:  2400.


tigarc has been entered in the Snivel Log for the period
900624 from 1200 to 2400.


        FLIGHT SCHEDULE

        1  Database
        2  Changes
        3  Snivels
        4  Print
        5  Completions
        6  Change files
        7  Quit

    Enter choice, 1 to 7:  4.
```

```
                         FLIGHT SCHEDULE
                            900624


EVT :SQDN :T/O :INSTRUCTOR   :STUDENT     :FLIGHT :ETE  :SIDE # :D/S :TY  :HRS :I/C :REMARK
  1 :  22 : 700:sim          :mendiolam   :ri3s   :2    :_____:____:____:____:____:2F90
  1 :  22 : 700:sim          :thienep     :bi4s   :2    :_____:____:____:____:____:2F90
  2 :  22 : 735:zarchya      :oehlert     :ri15x  :1.5  :_____:____:____:____:____:*
  2 :  22 : 735:sim          :chankleg    :ri11xs :2    :_____:____:____:____:____:2F90
  3 :  22 : 810:rolloww      :millerc     :an7    :1.6  :_____:____:____:____:____:*
  3 :  22 : 810:crossmana    :zogers      :fam2   :1.4  :_____:____:____:____:____:*
  4 :  22 : 845:hiltonc      :clinek      :fam3   :1.4  :_____:____:____:____:____:*
  4 :  22 : 845:fletcherj    :harrowb     :fam8   :1.4  :_____:____:____:____:____:*
  5 :  22 : 920:nordeen      :vanekc      :form2x :1.4  :_____:____:____:____:____:w/21
  5 :  22 : 920:waltersa     :huffw       :tacf1  :1.4  :_____:____:____:____:____:*
  6 :  22 : 955:paparoj      :lambb       :ocf3   :0.8  :_____:____:____:____:____:*
  6 :  22 : 955:bussmannl    :xet         :acm6x  :1.1  :_____:____:____:____:____:*
  7 :  22 :1030:patrickm     :bradleyw    :ocf3   :1.1  :_____:____:____:____:____:*
  7 :  22 :1030:merilosl     :jonesh      :acm13  :1.2  :_____:____:____:____:____:*
  8 :  22 :1105:hulsed       :garciae     :acm11x :1.2  :_____:____:____:____:____:*
  8 :  22 :1105:seymourw     :taffp       :acm13  :1.2  :_____:____:____:____:____:*
  9 :  22 :1140:fletcherj    :glasurep    :bi9    :1.4  :_____:____:____:____:____:*
  9 :  22 :1140:sim          :leckiew     :co7s   :2    :_____:____:____:____:____:2F90
 10 :  22 :1215:mesmerk      :tigarb      :fam6   :1.4  :_____:____:____:____:____:*
 10 :  22 :1215:crossv       :leetchk     :fam2   :1.4  :_____:____:____:____:____:*
 11 :  22 :1250:gallaghers   :aasena      :form4x :1.4  :_____:____:____:____:____:w/21
 11 :  22 :1250:pitzerg      :burrt       :on5x   :1.4  :_____:____:____:____:____:*
 12 :  22 :1325:myerss       :healdh      :on4    :1.5  :_____:____:____:____:____:*
 12 :  22 :1325:sessip       :cruzb       :acm13  :1.2  :_____:____:____:____:____:*
 13 :  22 :1400:sim          :farquharsonp:bi7s   :2    :_____:____:____:____:____:2F90
 13 :  22 :1400:hatteryk     :mcclured    :bi10x  :1.4  :_____:____:____:____:____:*
 14 :  22 :1435:hiltonc      :spagnoloe   :ri15x  :1.5  :_____:____:____:____:____:*
 14 :  22 :1435:sim          :simona      :co7s   :2    :_____:____:____:____:____:2F90
 15 :  22 :1510:johnsons     :belloc      :fam10  :0.6  :_____:____:____:____:____:*
 15 :  22 :1510:crossmana    :gangia      :fam5   :1.4  :_____:____:____:____:____:*
 16 :  22 :1545:waltersa     :finleyy     :tacf2  :1.4  :_____:____:____:____:____:*
 16 :  22 :1545:rolloww      :bello       :acm1   :1.1  :_____:____:____:____:____:*
 17 :  22 :1620:nordeen      :bakerk      :acm5   :1.1  :_____:____:____:____:____:*
 17 :  22 :1620:sim          :atkinsonm   :bi6s   :2    :_____:____:____:____:____:2F90
 26 :  22 :2135:maurerw      :curryy      :nf2    :0.8  :_____:____:____:____:____:*
 26 :  22 :2135:boronkay     :beavenr     :nf1    :1.4  :_____:____:____:____:____:*
 27 :  22 :2210:johnsons     :aasena      :nf1    :1.4  :_____:____:____:____:____:*
 27 :  22 :2210:bruruda      :bakerk      :acm5   :1.1  :_____:____:____:____:____:*
Press any key to continue.m.
```

```
FLIGHT SCHEDULE

        1  Database
        2  Changes
        3  Snivels
        4  Print
        5  Completions
        6  Change files
        7  Quit

        Enter choice, 1 to 7:  7.
Do you want to quit?  y.


    Closing data files . . .
```

```
/********************************************************************/
/*                    INSTRUCTOR REPLACEMENT                       */
/*                                                                  */
/*      Resulting in a complete rescheduling of the time period    */
/********************************************************************/


ai3% prolog
C-Prolog version 1.5
| ?- [reschedule].

        Loading data . . .

database consulted 167528 bytes 28.6833 sec.
update_database consulted 6628 bytes 0.783339 sec.
snivel_log consulted 752 bytes 0.150007 sec.
update_snivel_log consulted 5868 bytes 0.666679 sec.
change_personnel consulted 10100 bytes 1.21668 sec.
completions consulted 2604 bytes 0.300007 sec.
print consulted 3160 bytes 0.366688 sec.

        Remove instructor segment qualifications expiring as of what date?   900624.

        The ri qualification for burgan has been removed.
        The ri qualification for fletcherj has been removed.
        The cq qualification for bussmannl has been removed.
        The tacf qualification for nordeen has been removed.
              END INSTRUCTOR QUALIFICATION UPDATE.


                  FLIGHT SCHEDULE

                  1  Database
                  2  Changes
                  3  Snivels
                  4  Print
                  5  Completions
                  6  Change files
                  7  Quit

              Enter choice, 1 to 7:   2.
What file do you want to work with?   skedfacts.

Loading schedule file . . .

skedfacts consulted 2376 bytes 0.466679 sec.
        skedfacts is now open.


                  CHANGE PERSONNEL

                  1  Change Instructor
                  2  Change Student
                  3  Quit

              Enter choice, 1 to 3:   1.
```

Enter instructor name: rolloww.

Enter log-out time: 0800.

Enter log-in time: 1400.

rolloww has been entered in the Snivel Log for the period
900624 from 800 to 1400.

Searching . . .

All flights for rolloww have been adjusted.

FLIGHT SCHEDULE

    1 Database
    2 Changes
    3 Snivels
    4 Print
    5 Completions
    6 Change files
    7 Quit

Enter choice, 1 to 7:   4.

FLIGHT SCHEDULE
900624

EVT	SQDN	T/O	INSTRUCTOR	STUDENT	FLIGHT	ETE	SIDE #	D/S	TY	HRS	I/C	REMARKS
1	22	700	sim	mendiolam	ri3s	2						2F90
1	22	700	sim	thienep	bi4s	2						2F90
2	22	735	zarchya	oehlert	ri15x	1.5						*
2	22	735	sim	chankleg	rillxs	2						2F90
3	22	810	zupicj	lordg	fam10	0.6						*
3	22	810	crossmana	zogers	fam2	1.4						*
4	22	845	hiltonc	clinek	fam3	1.4						*
4	22	845	fletcherj	harrowb	fam8	1.4						*
5	22	920	nordeen	vanekc	form2x	1.4						w/21
5	22	920	waltersa	huffw	tacf1	1.4						*
6	22	955	paparoj	lambb	ocf3	0.8						*
6	22	955	bussmannl	xet	acm6x	1.1						*
7	22	1030	patrickm	bradleyw	ocf3	1.1						*
7	22	1030	merilosl	jonesh	acm13	1.2						*
8	22	1105	hulsed	garciae	acm11x	1.2						*
8	22	1105	seymourw	taffp	acm13	1.2						*
9	22	1140	garreltsb	glasurep	bi9	1.4						*
9	22	1140	sim	leckiew	co7s	2						2F90
10	22	1215	mesmerk	tigarb	fam6	1.4						*
10	22	1215	crossv	leetchk	fam2	1.4						*
11	22	1250	gallaghers	aasena	form4x	1.4						w/21
11	22	1250	pitzerg	burrt	on5x	1.4						*
12	22	1325	myerss	healdh	on4	1.5						*
12	22	1325	sessip	cruzb	acm13	1.2						*
13	22	1400	sim	farquharsonp	bi7s	2						2F90
13	22	1400	hatteryk	mcclured	bi10x	1.4						*
14	22	1435	hiltonc	spagnoloe	ri15x	1.5						*
14	22	1435	sim	simona	co7s	2						2F90
15	22	1510	crossmana	gangia	fam5	1.4						*
15	22	1510	johnsons	tigarc	form3	1.4						w/21
16	22	1545	waltersa	finleyy	tacf2	1.4						*
16	22	1545	rolloww	bello	acm1	1.1						*
17	22	1620	nordeen	bakerk	acm5	1.1						*
17	22	1620	sim	atkinsonm	bi6s	2						2F90
26	22	2135	maurerw	curryy	nf2	0.8						*
26	22	2135	boronkay	beavenr	nf1	1.4						*
27	22	2210	johnsons	aasena	nf1	1.4						*
27	22	2210	bruruda	bakerk	acm5	1.1						*

Press any key to continue.m.

```
FLIGHT SCHEDULE

        1   Database
        2   Changes
        3   Snivels
        4   Print
        5   Completions
        6   Change files
        7   Quit

        Enter choice, 1 to 7:   7.
Do you want to quit?   y.


    Closing data files . . .
```

```
/********************************************************************/
/*                      STUDENT REPLACEMENT                       */
/*                                                                */
/*      Resulting in a complete rescheduling of the time period   */
/********************************************************************/
```

ai3% prolog
C-Prolog version 1.5
| ?- [reschedule].

        Loading data . . .

database consulted 167528 bytes 28.6667 sec.
update_database consulted 6628 bytes 0.783339 sec.
snivel_log consulted 664 bytes 0.133337 sec.
update_snivel_log consulted 5868 bytes 0.683342 sec.
change_personnel consulted 10100 bytes 1.21667 sec.
completions consulted 2604 bytes 0.333336 sec.
print consulted 3160 bytes 0.383358 sec.

        Remove instructor segment qualifications expiring as of what date?   900624.

        The ri qualification for burgan has been removed.
        The ri qualification for fletcherj has been removed.
        The cq qualification for bussmannl has been removed.
        The tacf qualification for nordeen has been removed.
                END INSTRUCTOR QUALIFICATION UPDATE.

                FLIGHT SCHEDULE

                        1   Database
                        2   Changes
                        3   Snivels
                        4   Print
                        5   Completions
                        6   Change files
                        7   Quit

                Enter choice, 1 to 7:   2.
What file do you want to work with?   skedfacts.

Loading schedule file . . .

skedfacts consulted 2376 bytes 0.433346 sec.
                skedfacts is now open.

                CHANGE PERSONNEL

                        1   Change Instructor
                        2   Change Student
                        3   Quit

                Enter choice, 1 to 3:   2.

Enter student name: glasurep.

Enter log-out time: 0001.

Enter log-in time: 2400.

glasurep has been entered in the Snivel Log for the period
900624 from 1 to 2400.

Searching . . .

All flights for glasurep have been adjusted.

FLIGHT SCHEDULE

1 Database
2 Changes
3 Snivels
4 Print
5 Completions
6 Change files
7 Quit

Enter choice, 1 to 7: 4.

FLIGHT SCHEDULE
900624

EVT	:SQDN	:T/O	:INSTRUCTOR	:STUDENT	:FLIGHT	:ETE	:SIDE #	:D/S	:TY	:HRS	:I/C	:REMARKS
1 :	22 :	700:	sim	:mendiolam	:ri3s	:2	:	:	:	:	:	:2F90
1 :	22 :	700:	sim	:thienep	:bi4s	:2	:	:	:	:	:	:2F90
2 :	22 :	735:	zarchya	:oehlert	:ri15x	:1.5	:	:	:	:	:	:*
2 :	22 :	735:	sim	:chankleg	:ri11xs	:2	:	:	:	:	:	:2F90
3 :	22 :	810:	rolloww	:millerc	:an7	:1.6	:	:	:	:	:	:*
3 :	22 :	810:	crossmana	:zogers	:fam2	:1.4	:	:	:	:	:	:*
4 :	22 :	845:	hiltonc	:clinek	:fam3	:1.4	:	:	:	:	:	:*
4 :	22 :	845:	fletcherj	:harrowb	:fam8	:1.4	:	:	:	:	:	:*
5 :	22 :	920:	nordeen	:vanekc	:form2x	:1.4	:	:	:	:	:	:w/21
5 :	22 :	920:	waltersa	:huffw	:tacf1	:1.4	:	:	:	:	:	:*
6 :	22 :	955:	paparoj	:lambb	:ocf3	:0.8	:	:	:	:	:	:*
6 :	22 :	955:	bussmannl	:xet	:acm6x	:1.1	:	:	:	:	:	:*
7 :	22 :	1030:	patrickm	:bradleyw	:ocf3	:1.1	:	:	:	:	:	:*
7 :	22 :	1030:	merilosl	:jonesh	:acm13	:1.2	:	:	:	:	:	:*
8 :	22 :	1105:	hulsed	:garciae	:acm11x	:1.2	:	:	:	:	:	:*
8 :	22 :	1105:	seymourw	:taffp	:acm13	:1.2	:	:	:	:	:	:*
9 :	22 :	1140:	zarchya	:ratliffh	:ri15x	:1.5	:	:	:	:	:	:*
9 :	22 :	1140:	sim	:leckiew	:co7s	:2	:	:	:	:	:	:2F90
10 :	22 :	1215:	mesmerk	:tigarb	:fam6	:1.4	:	:	:	:	:	:*
10 :	22 :	1215:	crossv	leetchk	:fam2	:1.4	:	:	:	:	:	:*
11 :	22 :	1250:	gallaghers	:aasena	:form4x	:1.4	:	:	:	:	:	:w/21
11 :	22 :	1250:	pitzerj	:burrt	:on5x	:1.4	:	:	:	:	:	:*
12 :	22 :	1325:	myerss	:healdh	:on4	:1.5	:	:	:	:	:	:*
12 :	22 :	1325:	secsip	:cruzb	:acm13	:1.2	:	:	:	:	:	:*
13 :	22 :	1400:	sim	:farquharsonp	:bi7s	:2	:	:	:	:	:	:2F90
13 :	22 :	1400:	hatteryk	:mcclured	:bi10x	:1.4	:	:	:	:	:	:*
14 :	22 :	1435:	hiltonc	:spagnoloe	:ri15x	:1.5	:	:	:	:	:	:*
14 :	22 :	1435:	sim	:simona	:co7s	:2	:	:	:	:	:	:2F90
15 :	22 :	1510:	crossmana	:gangia	:fam5	:1.4	:	:	:	:	:	:*
15 :	22 :	1510:	johnsons	:tigarc	:form3	:1.4	:	:	:	:	:	:w/21
16 :	22 :	1545:	waltersa	:finleyy	:tacf2	:1.4	:	:	:	:	:	:*
16 :	22 :	1545:	rolloww	:bello	:acm1	:1.1	:	:	:	:	:	:*
17 :	22 :	1620:	nordeen	:bakerk	:acm5	:1.1	:	:	:	:	:	:*
17 :	22 :	1620:	sim	:atkinsonm	:bi6s	:2	:	:	:	:	:	:2F90
26 :	22 :	2135:	maurerw	:curryy	:nf2	:0.8	:	:	:	:	:	:*
26 :	22 :	2135:	boronkay	:beavenr	:nf1	:1.4	:	:	:	:	:	:*
27 :	22 :	2210:	johnsons	:aasena	:nf1	:1.4	:	:	:	:	:	:*
27 :	22 :	2210:	bruruda	:bakerk	:acm5	:1.1	:	:	:	:	:	:*

Press any key to continue.m.

FLIGHT SCHEDULE

     1 Database
     2 Changes
     3 Snivels
     4 Print
     5 Completions
     6 Change files
     7 Quit

Enter choice, 1 to 7:   7.
Do you want to quit?   y.

Closing data files . . .

REFERENCES

[1]   O'Brien, J. J., *Scheduling Handbook*, p. 1, McGraw-Hill Book Company, 1969.

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